NAVAL SHIPS' TECHNICAL MANUAL

CHAPTER 581

ANCHORING

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CHAPTER 581

ANCHORING

SECTION 1.
GENERAL INFORMATION AND SAFETY PRECAUTIONS

581-1.1 GENERAL INFORMATION

581-1.1.1 PURPOSE. The purpose of NSTM Chapter 581, Anchoring, is to provide technical information regarding operation, maintenance, inspection, testing and safety precautions related to ground tackle equipment used on U.S. Navy ships. Anchor, chain, appendage and related data, contained herein and reflecting applicability to submarines, is valid and applies size for size to submarine anchor systems. Anchor and ballguide assemblies are shown on NAVSEA dwg 803-5000920.

581-1.1.2 ANCHORING EQUIPMENT. Anchoring equipment includes the windlass, wildcat, capstan, gypsy head, stern anchor winch, anchor, anchor chain and anchor chain appendages. Anchor chain appendages include detachable links, mooring swivels, chain swivels, ball guide assemblies, pear-shaped detachable links, end links, bending shackles, mooring shackles, bitter end shackles, detachable link tool sets, clear hawse pendants, dip ropes, chain stoppers, chain stopper wrenches, outboard swivel shots, chain hooks and cable jacks. Anchor, chain and chain appendages are classified as ground tackle.

581-1.2 SAFETY PRECAUTIONS

581-1.2.1 There are many foot, hand, head and eye hazards when working with ground tackle. Refer to OPNAVINST 5100.19, Navy Safety Precautions for Forces Afloat, for guidance. Proper supervision and good judgement is paramount when considering personnel safety.

581-1.2.2 Rousing out anchors or anchor chain onto a drydock floor, barge or pier for inspection, overhaul or preservation is an extremely dangerous operation that must be supervised by experienced personnel. There is danger of the anchor being accidentally dropped, or the chain taking charge and running uncontrollably over the wildcat and sliding back down the chain pipe or over the side of the ship, barge or pier.

581-1.2.3 Always observe the following safety precautions:

a. Be alert at all times for possible malfunctioning of equipment. Ensure locking heads are fully engaged before operating wildcat.

b. Wear snug-fitting clothing, safety goggles, safety shoes, gloves and safety helmets.

c. Wear an approved life preserver on a barge or pier while rousing out or restowing anchors or anchor chain.

d. Keep hands and feet off, and away from, moving anchor chains.

e. Personnel working on the drydock floor, barge or pier should always stand clear while lowering or raising the anchor for inspection or overhaul.

f. Never step over, on, or straddle the anchor chain or stand between the chain and the side of the ship during rousing out or restowing operations.

g. Clean oily deck areas promptly.

h. Spread salt or sand on icy area.

i. Do not walk backwards.

j. Enter the chain locker only when permission is given by the officer in charge, no anchor operations are planned and the space is certified as gas free.

k. Prior to starting anchor handling operations, ensure all non-operating personnel are clear of the area.

l. When disconnecting the anchor chain, backup the outboard chain stopper with a wire rope preventer above the hawse pipe to prevent dropping the anchor accidentally. Also, secure the anchor chain above the chain pipe using a wire rope preventer or a pinch bar to prevent chain from running back into the chain locker.

m. Fully disengage the wildcat locking head and ensure the wildcat brake is set before starting the windlass. Partial engagement of the wildcat locking head can result in equipment damage.

n. Ensure the wildcat hand brake is set before tripping the chain stopper.

o. Engage the anchor chain with the wildcat and use the wildcat when rousing out or restowing anchor chain.

p. When rousing out chain onto a barge that has no retaining sides or on a pier that is not directly under the hawse pipe, ensure that each shot of chain is controlled with rope stops so that the anchor chain will not take charge and run uncontrollably over the side.

q. When hauling in anchor chain from depths of more than 60 fathoms, do not exceed half speed.

r. House anchor in the hawse pipe at the lowest speed range.

s. Remove ropes and lines from the capstan or gypsy heads before using the wildcat.

t. Keep clear of rotating machinery when it is operating. Do not operate rotating machinery with guards and covers removed.

u. Do not use chain hooks during rigging operations for rousing out anchor chain.

v. When at sea, ensure, on a daily basis, that the wildcat is disconnected, the brake is set and the chain stoppers are equally taut.

w. When at anchor, a detachable link should be inboard of the outboard chain stopper and the detachable tool kit shall be available to let go the anchors in an emergency.

x. When dropping anchor, do not let the chain take charge. Control the chain speed by applying and releasing the hand brake or lowering the anchor under power.

y. The safe working load of hauling and easing out lines shall be equal to the applicable dip rope size.

z. When securing the bitter end of the chain in the chain locker, ensure that there are no twists in the chain between the bitter end and the wildcat.

aa. Before operating the windlass or removing the preventor or bar, ensure that the wildcat is engaged and the chain is under control.

SECTION 2.
ANCHORING

581-2.1 GENERAL INFORMATION

581-2.1.1 ANCHORING GUIDELINES. The following paragraphs present guidelines and methods for anchoring. The anchoring conditions determine the length of anchor chain that the ship's force will use to secure the ship's position.

581-2.1.2 PRECAUTIONS. When anchoring, adhere to the following precautions and conditions:

a. Never drop two anchors simultaneously.

b. Maintain an anchor watch when anchored or moored to a buoy.

c. Do not allow the anchor chain to tend across the stem (lead around the ship's bow).

d. Do not use the anchor to stop the ship.

e. Anchoring nomographs are based on a flat-bottom condition. Always use the correction factor for a sloped-bottom nomograph.

f. Check target point dimensions on nomographs. Do not use reduced-sized or reprinted copies.

g. Pay out the anchor to within 15 fathoms of seabed and free-fall the anchor the remaining distance when anchoring in depths exceeding 15 fathoms.

h. Anchoring should not be done in depths exceeding 100 fathoms.

581-2.1.3 DESIGN CONDITIONS. Anchoring system design is based on a 70-knot wind and a 4-knot current in 40 fathoms of water, in a firm sand bottom with the wind and current bow on. The maximum force a ship exerts on the anchor line under design conditions is the horizontal force or the ship's total resistance (hull and locked propeller(s) drag and wind force), and is equal to the force exerted on ANCHORING the ship's anchor. An anchor is then selected that has a holding power equal to or greater than the ship's resistance.

NOTE

When anchoring in a mud bottom, the holding power of the anchor is less than in sand, and the ship may have a tendency to drag anchor.

581-2.1.4 ANCHOR HOLDING POWER. Anchor holding power has been determined by full-scale anchor drag tests in a firm sand bottom. It has been determined from anchor drag tests in unconsolidated sediments such as mud or a mix of mud, clay and sand, that anchors have maximum holding power in firm sand. In addition, full-scale anchor drag tests have demonstrated that the holding power of an anchor in a mud bottom is purely a function of the type of mud. However, anchors deeply embedded in mud may develop sufficient holding power.

581-2.1.5 ANCHOR CHAIN SIZE. The anchor type and size is selected based on the wind resistance force, the hull hydrodynamic drag force, the locked propeller drag force and a dynamic motion factor applied depending on ship type. The chain size reflects a factor of safety of five, based on the forces and factors above, plus the resultant tension due to the catenary effect, all of which equal the chain tension at the ship's bolster.

581-2.1.6 CHAIN LENGTH. The length of chain is determined after the chain size is selected. The controlling factor in determining the length of the chain is the requirement that the anchor shank must remain horizontal in order to develop maximum anchoring forces. This assumes that the bottom is flat and horizontal. The chain from the ship to the anchor will conform to a curve in the shape of a catenary. If the catenary is short, the chain will lift the anchor shank off the bottom and reduce the anchor holding power. The further the anchor shank lifts off the bottom, the less the anchor holding power.

581-2.1.7 SHIP'S GROUND TACKLE SIZE AND QUANTITY. The hull allowance lists specify the size, weight, amount and type of ground tackle equipment, including spares, that should be onboard in-service ships. This information is also contained in the Ship's Information Book (SIB). All discrepancies between the Coordinated Ships Allowable List (COSAL) or the SIB and the onboard ground tackle equipment should be reported to NAVSEA.

581-2.1.8 RESERVE STOCK OF GROUND TACKLE. A reserve stock of ground tackle is maintained at the Ships Parts Control Center (SPCC), Mechanicsburg, PA and the Defense General Supply Center (DGSC), Richmond, VA. The amounts of chain of various sizes, the number of chain appendages, the number, weight and type of anchors carried as stock by the various activities, and the method of replenishing stock is established by the Naval Supply Systems Command based on usage data. The home yard or assigned yard provides maintenance support for the ground tackle equipment as requested.

CAUTION

Do not use the ground tackle equipment to reduce the ship's headway. The forces will cause ground tackle equipment failures and possible loss.

581-2.1.9 REDUCING SHIP'S HEADWAY WITH GROUND TACKLE. The practice of using the ground tackle to reduce a ship's headway is dangerous and is to be avoided except under extreme emergency conditions. This practice will cause excessive forces in the ground tackle. If the forces exceed the proof test load applied by the manufacturer, the chain and appendages will undergo a plastic deformation, possibly fail or not fit the wildcat.

581-2.2 ANCHORING NOMOGRAPHS

581-2.2.1 PURPOSE. Anchoring nomographs have been prepared to determine the minimum length of chain and the horizontal distance from the ship to the anchor for flat and sloped bottoms. These nomographs represent the equations and model test data for a particular ship class. The nomograph is a tool for determining the ship's resistance to specific current and wind conditions, and the length of chain required for a specific depth and bottom slope, without resorting to calculations. A nomograph is also used to determine the horizontal distance from the ship to the anchor. Anchoring nomographs must be requested from the Naval Ship Systems Engineering Station (NAVSSES), Philadelphia, PA.

581-2.2.2 REQUIREMENTS. The anchoring nomographs apply only to the class of ship for which they are prepared. Do not use anchoring nomographs for any other class of ships, even if the ships have the same size anchors and chain. Requirements (a) through (d) below must be satisfied and the information available before using the anchoring nomographs:

a. Measure the distance between the target points on the nomograph. The distance between two target points on the short side of the nomograph is six inches and the distance between the two target point on the long side of the nomograph is eight inches. The diagonal distance between the extreme target points is 10 inches. Do not use distorted nomographs where the dimensions between the target points are different.

b. Current speed in knots.

c. Wind speed in knots.

d. Depth of water in feet.

581-2.2.3 USING ANCHORING NOMOGRAPH. A typical anchoring nomograph is illustrated in Figure 581-2-1. The following steps apply to all anchoring nomographs when anchoring on a flat bottom:

a. Mark the current, wind and depth of water on the appropriate scale.

b. Draw a straight line through the current and wind marks, and extend it to the ship's resistance scale.

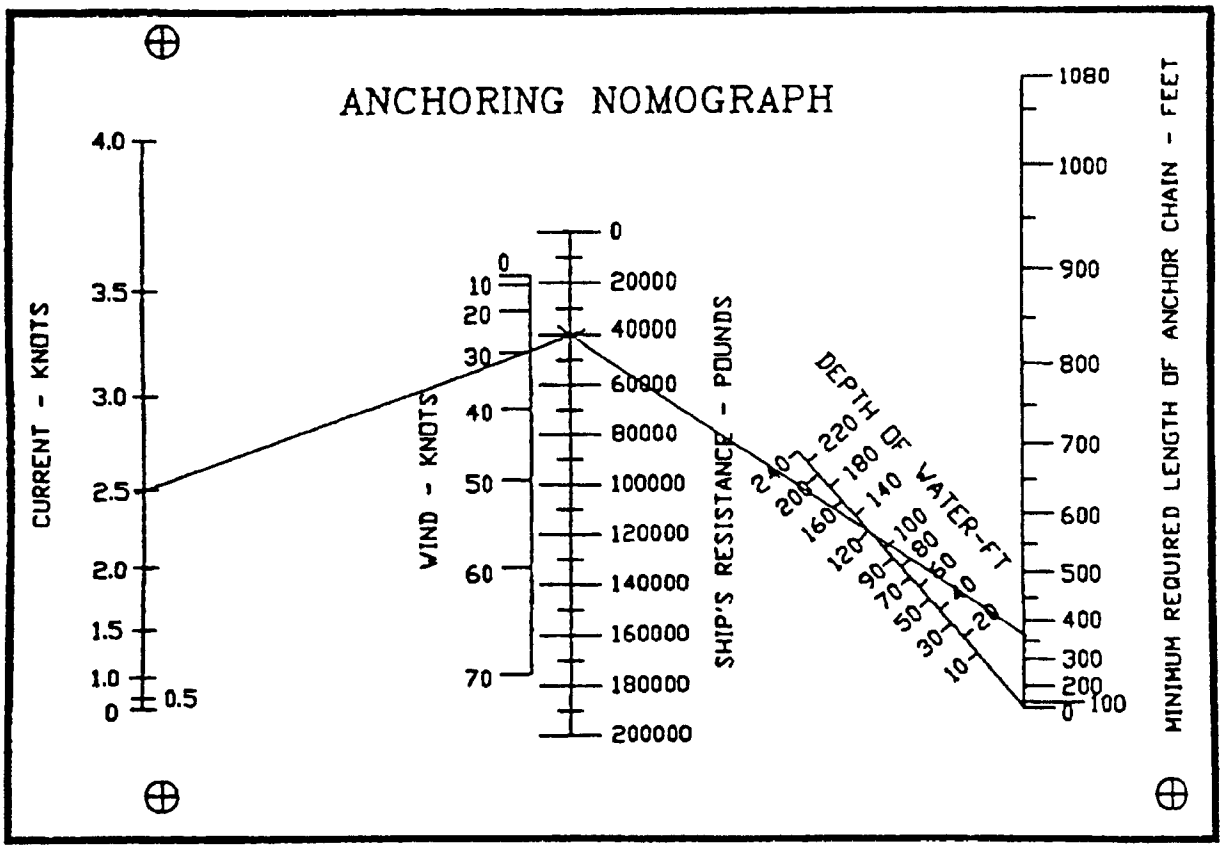
c. Draw a straight line from the ship's resistance scale through the depth of water marks and extend it to intersect the required length of anchor chain scale. This is the required length of chain to anchor on a flat bottom.

d. Mark the ship's resistance and the depth of water on the appropriate scales on the Distance from Ship to Anchor Nomograph (Figure 581-2-2). Ring the ship's anchor. An anchor is then selected that has a holding power equal to or greater than the ship's resistance.

e. Draw a straight line through the ship's resistance and depth of water marks and extend it to intersect the distance from ship to anchor scale.

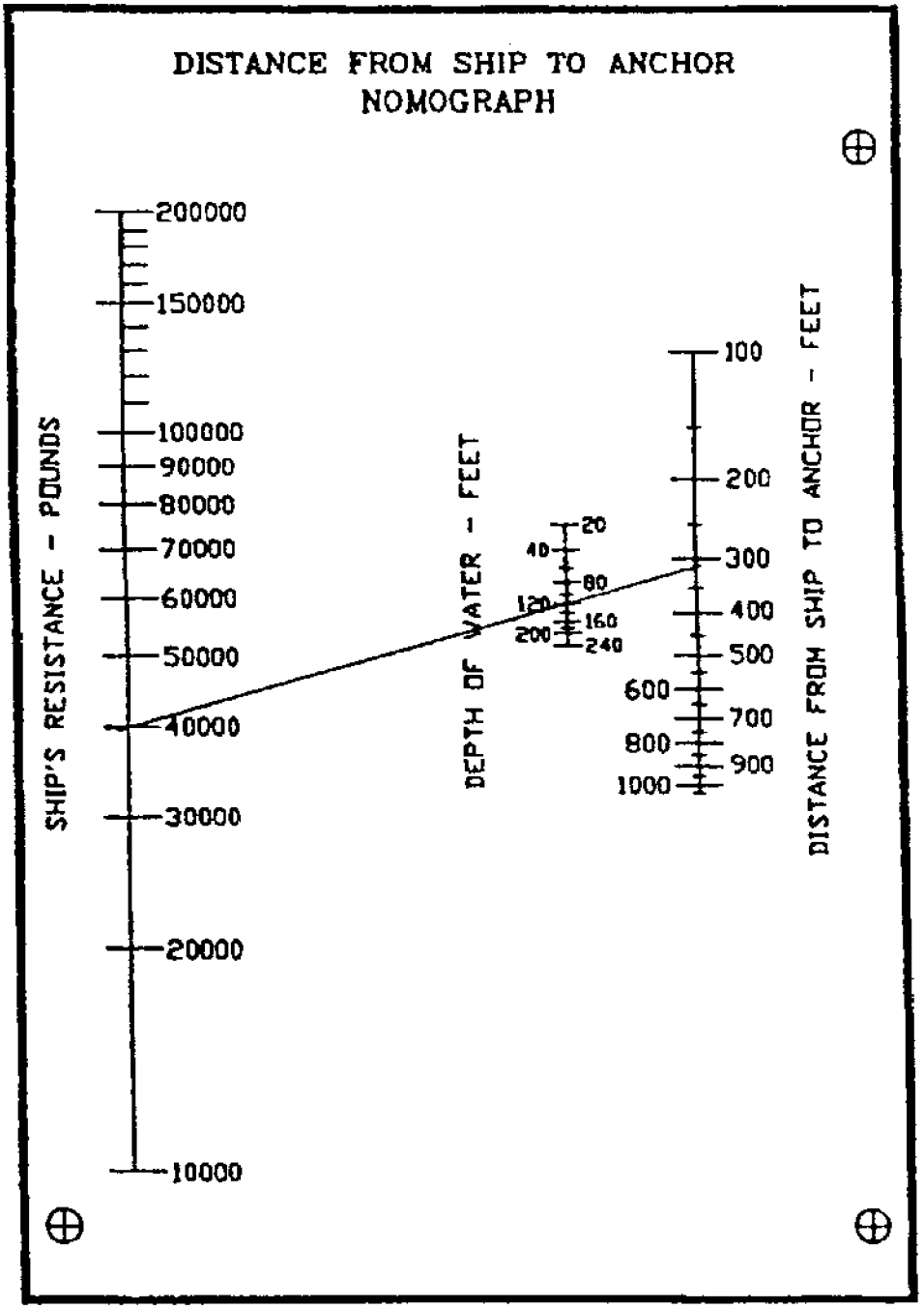
CAUTION

Do not anchor on a bottom slope greater than 40 degrees. The anchorage will not be secure and the ship will drag the anchor.



⊕ = TARGET POINT (THREE TARGET POINTS ARE REQUIRED)
GIVEN: 2.5 KNOTS - CURRENT
30 KNOTS - WIND
120 FEET - DEPTH OF WATER
THEN: SHIP'S RESISTANCE = 40,000 POUNDS
REQUIRED LENGTH OF ANCHOR CHAIN = 360 FEET

Figure 581-2-1 Sample Anchoring Nomograph



⊕ = TARGET POINT (THREE TARGET POINTS ARE REQUIRED)
GIVEN: 40,000 POUNDS - SHIP'S RESISTANCE
120 FEET - DEPTH OF WATER
THEN: DISTANCE FROM SHIP TO ANCHOR = 310 FEET

Figure 581-2-2 Sample Distance from Ship to Anchor Nomograph

581-2.2.4 ANCHORING NOMOGRAPHS FOR SLOPED BOTTOMS. For sloped- bottom nomographs, contact Naval Ships Systems Engineering Station (NAVSSES), Philadelphia, PA.

581-2.3 READINESS FOR USE

NOTE

In all cases, the detachable link tool kit and chain stopper tools (sledge hammer and turnbuckle adjustment wrench) must be available. Before the chain stoppers are passed and closed, the chain should be hauled in or paid out so that a detachable link is located inboard of the riding chain stopper.

581-2.3.1 AT SEA. When at sea, check daily to ensure that all chain stoppers are attached to the anchor chain and the anchor is housed tightly in the hawse pipe. The bail lock pin on the chain stoppers may be secured by figure eighting the lanyard on the pin and bringing the bail against the pin to prevent accidental opening of the chain stopper. This is commonly referred to as mousing the bail lock pin or chain stopper. Keep the detachable link tool kit available for use at all time since it may be necessary to disconnect the anchor chain from the outboard swivel shot for a towing evolution. Chain stoppers used during towing must be equipped with locking plates, modified eye bolts and cotter pins. See NAVSHIPS dwg 804-860000, PC's 17, 18,19 and 20.

NOTE

For ships equipped with bow anchors and a sonar dome, the anchor should be dropped with the ship backing down.

581-2.3.2 WHEN ANCHORING. In advance of approaching the anchoring point, prepare the windlass and wildcat for use. Attach marker buoys to the anchors with sufficient lengths of rope to match the depth of water where the anchorage is planned. Collect the tools needed to trip the chain stoppers and have personnel don required safety equipment. If more than one chain stopper is attached to the anchor chain, release the chain stoppers on the approach to the anchorage. As the ship reduces headway or starts backing down, prepare for anchorage. In depths of water 15 fathoms or less, release the hand brake and free-fall the anchor. In depths of water greater than 15 fathoms, pay out anchor using the windlass until 15 fathoms from seabed and free-all anchor remaining distance. When the anchor reaches bottom and the required length of chain is paid out, the wildcat hand brake is set and the chain stoppers are passed. When a ship is equipped with more than one anchor, the second anchor should be prepared as a back-up if the first anchor will not drop or the wildcat hand brake fails.

581-2.3.3 WHEN ANCHORED. When anchored, the anchor watch must be ready to take any of the actions listed below:

a. Report to the officer in charge that the anchor chain is tending around the bow of the ship, the anchor is dragging under heavy strain or the ground tackle has failed.

b. Release the chain stoppers and haul in the anchor or pay out additional chain.

c. Drop the second anchor if the first anchor or chain fails. To avoid fouling the anchor chains, do not drop the second anchor until most of the remaining anchor chain has been hauled in.

d. Disconnect the inboard detachable link and release the riding stopper(s). Take these actions only when time is limited and the windlass cannot be used to haul in the anchor chain.

e. If the capability exists, disconnect the detachable links and crossconnect the anchor chains if a windlass drive fails when hauling in the anchor.

581-2.3.4 WHEN HAULING IN ANCHOR. When hauling in the anchor chain, station two engineers to inspect the anchor for cracks, bent flukes or a bent shank and the anchor chain for cracks, missing studs, twisted links or other defects. They should be ready to report defects and be ready to remove mud and other debris on the chain and appendages. Windlass operators should also be ready to apply the wildcat hand brake if the windlass drive stops.

581-2.4 GENERAL OPERATING INSTRUCTIONS

581-2.4.1 PREPARATION FOR OPERATION. Consult the equipment operating and technical manuals. Inspect the equipment and maintain it in proper operating condition at all times, including proper lubrication.

a. Consult the technical manual or lubrication chart for the recommended grades of lubricant, frequency of application and points of application. Do not allow oil or grease to accumulate on or around the windlass.

b. Keep equipment clean and do not store or lay heavy objects on any part of the windlass, wildcat, capstan or drive.

c. In cold weather, check equipment condition before starting to operate the windlass. Remove ice which would interfere with rotation of any part of the windlass or which would block movement of the anchor or chain. Operate the electrohydraulic drive to bring the hydraulic fluid up to operating temperature, 140 degrees F, before hoisting or lowering the anchor or operating the capstan.

d. Observe all safety precautions contained in Section 1.

581-2.4.2 ELECTROHYDRAULIC WINDLASS OPERATION. Before operating the anchor windlass, consult the applicable equipment technical manual for detailed instructions.

581-2.4.2.1 Hoist or Lower with Power. To hoist or lower the anchor and chain:

1. Place hydraulic pump stroke controls on neutral (zero-stroke).
2. Start main hydraulic pump electric motor. Ensure that the wildcat locking head is disengaged.
3. Operate the windlass to ensure hoisting or lowering setting is correct.
4. Engage wildcat locking head.
5. Release wildcat hand brake.
6. Take in slack to remove stain from chain stoppers.
7. Set the wildcat hand brake.
8. Release chain stoppers.
9. Use the hydraulic pump stroke control handwheel to raise or lower the anchor as desired.
10. Place hydraulic pump stroke control on neutral.
11. Set the wildcat hand brake.
12. Pass the chain stoppers on the anchor chain.

13. Disengage the wildcat locking head.
14. Turn off main hydraulic pump electric motor.

581-2.4.2.2 Free-Fall Without Power. To let the anchor fall free:

1. Set the wildcat hand brake.
2. Disengage the wildcat locking head.
3. Release chain stoppers.
4. Release wildcat hand brake.
5. Control speed of chain run out by applying and releasing the hand brake.
6. When desired amount of chain has run out, apply the hand brake to stop and hold the anchor and chain.
7. Pass the chain stoppers on the anchor chain.
8. Adjust chain stoppers to take equal loading.

581-2.4.2.3 Capstan Use. To use the capstan:

1. Set wildcat hand brake.
2. Disengage wildcat locking head.
3. Place hydraulic pump stroke controls on neutral.
4. Start main hydraulic pump electric motor.
5. Pass rope or line on capstan.
6. Use hydraulic pump stroke control handwheel to rotate head at desired speed in either direction.
7. Place hydraulic pump stroke controls on neutral.
8. Turn off main hydraulic pump electric motor.
9. Remove rope or line from capstan.

581-2.4.3 ELECTROMECHANICAL WINDLASS OPERATION. Before operating the anchor windlass, consult the applicable equipment technical manual for detailed instructions.

CAUTION

Ensure that wildcat locking head is disengaged.

581-2.4.3.1 Hoist or Lower with Power. To hoist or lower the anchor and chain:

1. Operate electric motor master switch to rotate the wildcat in the desired direction at the desired speed.
2. Engage wildcat locking head.
3. Release wildcat hand brake.

4. Take in slack.
5. Set wildcat hand brake.
6. Release chain stoppers.
7. Release hand brake.
8. Use the switches to raise or lower the anchor as desired.
9. Set the wildcat hand brake.
10. Pass and close the chain stoppers on the anchor chain.
11. Adjust chain stoppers to take equal loading.
12. Disengage wildcat locking head.

581-2.4.3.2 Free-Fall Without Power. To let the anchor fall free:

1. Set wildcat hand brake.
2. Disengage wildcat locking head.
3. Release chain stoppers.
4. Release wildcat hand brake.
5. Control speed of chain run out by applying and releasing the hand brake.
6. When desired amount of chain has run out, apply the hand brake to stop and hold the anchor and chain.
7. Pass and close the chain stoppers on the anchor chain.
8. Adjust chain stoppers to take equal loading with the wildcat.

581-2.4.3.3 Capstan Use. To use the capstan:

1. Set wildcat hand brake.
2. Disengage wildcat locking head.
3. Pass rope or line on capstan.
4. Operate electric motor master switch to rotate the capstan in the desired direction at the desired speed.
5. Remove rope or line from capstan.

581-2.4.4 ANCHOR WINDLASS FREE-FALL GUIDANCE.

581-2.4.4.1 General. Many ships may experience difficulty free-falling their anchors from the housed position. The following guidance is provided to correct and troubleshoot free-fall problems.

581-2.4.4.2 Bushing Flush. The most common cause of anchors not free-falling is fouling of the wildcat and capstan shaft bushings. Fouling occurs as a result of deteriorated greases, dried salt spray and dirt particles accumulating between wildcat and capstan bushings and shafting. Accomplish the following flushing and lubrication procedure, when an unexpected free-fall problem occurs:

CAUTION

Follow standard ship procedures, and exercise extreme caution, when removing and reinstalling anchor chain. Ensure that anchor chain is properly secured at hawse pipe and chain pipe to prevent chain slippage.

a. Remove the anchor chain from the wildcat so that the wildcat and capstan (if applicable) are free to rotate under power.

b. Remove the zerk fittings from the lubrication ports associated with the capstan (if applicable) and wildcat bushings.

c. Connect the discharge hose of a pneumatic grease gun filled with hydraulic fluid, MIL-H-17672, SYM 2135TH or MIL-L-17331, 2190TEP, directly to the bushing lubrication ports.

NOTE

Steps d and e are only applicable to windlasses consisting of one wildcat and one capstan head mounted above the wildcat.

d. Disengage the wildcat and set the brake

CAUTION

Be sure to use rags in the area of the brake drum and brake linings to contain the oil when the oil runs freely from the bushing.

Observe all safety precautions while rotating machinery.

e. Rotate the capstan under power at both low and high speeds. While rotating the capstan, pump the oil into the various lubricant ports for the capstan shaft until the oil runs freely from the bushings.

NOTE

Inspect flushed oil for bronze (bushing) particles. Presence of bronze indicates bushing wear.

f. Perform step e flushing procedure for wildcat shaft lubricant ports with the wildcat engaged and brake released.

NOTE

Inspect flushed oil for bronze (bushing) particles. Presence of bronze indicates bushing wear.

g. After flushing, reinstall new zerk fittings.

h. Rotate wildcat and lubricate capstan (if applicable) and wildcat bushings with the recommended type and quantity of grease.

i. Place the anchor chain back on the wildcat. Raise and lower the anchor under power.

j. Set the brake and disengage the wildcat.

k. Test for free-fall of the anchor from the housed position.

581-2.4.4.3 Operational Assistance for Free-Fall Problems. Steps 581-2.4.4.3.1, 581-2.4.4.3.2, or 581-2.4.4.3.3 should be followed in that order of difficulty.

581-2.4.4.3.1 Free-Fall from Unhoused Position. With the chain stoppers passed, the wildcat engaged, and brake set:

a. Cast off chain stoppers.

b. Release the brake.

c. Payout the anchor to eliminate contact with the bolster.

d. Set the brake.

e. Pass housing stopper.

f. Disengage the wildcat.

g. At Standby - Cast off stopper.

h. Free-fall the anchor by releasing the brake. Control the speed of the anchor and chain by applying the brake.

581-2.4.4.3.2 Free-Fall from Slacked Chain Condition. With the chain stoppers passed, the wildcat engaged, and brake released:

a. Cast off the riding chain stopper.

b. Walkout some chain on the deck between the wildcat and the housing chain stopper to provide some slack in the chain (i.e., lay enough chain on the deck to allow the stopper to take the strain for the anchor).

c. Set the brake.

d. Disengage the wildcat.

e. At standby - Release the brake.

f. Free-fall the anchor from the housing chain stopper. Control the speed of the anchor and chain by applying the brake.

581-2.4.4.3.3 Free-Fall from Unhoused and Slacked Chain Condition. With the chain stoppers passed, the wildcat engaged, and brake set:

a. Slack and release the housing chain stopper.

b. Engage the pelican hook of this stopper to the first horizontal chain link abaft the link previously engaged.

c. Release the brake.

d. Heave in until the wildcat takes the strain.

e. Cast off the riding chain stopper.

f. Walkout some chain on the deck between the wildcat and the housing chain stopper to provide some slack in the chain (i.e., lay enough chain on the deck to allow the stopper to take the strain of the anchor).

g. Set the brake.

h. Disengage the wildcat.

i. At standby - Release the brake.

j. Free-fall the anchor from the housing chain stopper. Control the speed of the anchor and chain by applying the brake.

581-2.4.4.4 Additional Causes for an Anchor Not Free-Falling

a. Rough weld joints or grooves in the hawsepipe, or other unexpected resistance developed within the hawsepipe and anchor bolster.

b. Interference (binding or friction) from the hawsepipe, deck bolster or deck that would restrict the anchor chain from running free.

NOTE

Vegetable oil may be poured down the hawsepipe to eliminate excessive friction. However, limit the amount of oil poured down the hawsepipe so that there is not significant amount of sheen detectable on the water.

c. Binding in the mouth of the chain pipe. The chain should run horizontal (level) from the chain pipe bolster to the wildcat.

d. Manual brake does not release completely.

e. Kinking of chain in the chain locker.

f. Thrust washer worn out or binding.

581-2.4.4.5 Troubleshooting.

a. Inspect the clearance between brake drum and brake lining for any areas of binding with a feeler gage.

b. Check for bushing, bearing and thrust washer binding by performing the following:
   1. Remove the anchor chain from the wildcat.
   2. Disengage wildcat.
   3. Rotate the wildcat. For windlasses in general, the wildcat should rotate with less than 1000 ft-lbs torque.

581-2.4.5 HAND WINDLASS OPERATION. Operation of most of these mechanisms is self-evident. Consult the manufacturer’s technical manual for description and operating procedures.

581-2.4.6 STERN ANCHOR WINCH. Consult the manufacturer’s technical manual for maintenance, description and operating procedures.

581-2.5 FAILURE OR LOSS OF GROUND TACKLE

581-2.5.1 RECOVERY. Use every possible means to recover the anchor and chain if the ground tackle is lost. Also, recover as many pieces of the failed components as possible. Document and report the event and preserve the failed parts in accordance with paragraphs 581-2.5.2 through 581-2.5.5.

581-2.5.2 MARKING LOCATION OF LOSS. If the ship's force is not able to recover the lost ground tackle equipment, take bearings of the location and leave the anchor marker buoy. If a buoy was not deployed with the anchor, leave the buoy to mark the location of the lost ground tackle.

581-2.5.3 PRESERVATION OF FAILED PART. As soon as the failed pieces are recovered, clean the fractured surfaces with freshwater, dry the fractured surfaces and coat them with a heavy petroleum product such as grease or a conventional cellulosic lacquer to provide temporary protection. DO NOT USE EPOXY PAINT. Take several photographs of the fractured surfaces before applying the rust preventive compound. Tag the large failed pieces with the date and ship's hull number. Collect the small pieces in a container and tag with the date and ship's hull number.

581-2.5.4 INFORMATION REQUIRED. Collect and record, in a timely manner, the following information about the ground tackle failure or loss:

a. Date and time.

b. Wind speed and direction, current and direction, and sea condition.

c. Length of chain from hawse pipe to anchor.

d. Depth of water.

e. Bottom slope and condition (firm sand, mud, rock, etc.)

f. Special circumstances or unusual events, if any, that contributed to the failure or loss.

g. Description of failed parts and surfaces.

h. Apparent cause.

i. Statement that the lost ground tackle was or was not recovered. If only part was recovered, document which parts were lost.

j. Date of last ground tackle inspection by ship's force.

k. Statement that the requirements for ground tackle care and inspection have or have not been carried out.

l. Anchor type and weight. Also, include the manufacturer's name, if known, and anchor serial number, if assigned.

m. Size, type and quantity of chain and appendages. Also, include the manufacturer's name, if known.

581-2.5.5 REPORTING FAILURE OR LOSS. The ship's force is to forward the information required with photographs of the failed surfaces and a cover letter to NSWCCD-SSES, Code 9710, Philadelphia, PA 19112-5083 for failed anchor, chain and appendages.

581-2.5.6 DISPOSITION OF FAILED PARTS. NSWCCD-SSES, Philadelphia, PA, after initial evaluation of the failed component may request the ship to forward the failed chain links, appendages or anchor parts to their facility.

581-2.5.7 INVESTIGATION REPORT. NSWCCD-SSES, Code 9710, is the In-Service Engineering Agent (ISEA) and has the responsibility to investigate the ground tackle failure and loss. They will send copies of their investigation report to the ship involved and NAVSEA.

581-2.6 LEAD LINES

WARNING

Stand clear of the leadsman when the leadsman is swinging the sounding lead. Also, do not stand in the lead line rope that is faked out on the deck. The leadsman must wear a life jacket and mandatory safety equipment when taking depth measurements.

581-2.6.1 BACKGROUND. Lead lines are used to measure the depth of the water when charts are not available and the ship's fathometer (depth finder) is not operational. A typical lead line consists of a sounding lead and a length of rope marked to indicate the depth of water. The lead line is a tool used to measure the depth of water when the ship is going into or out of port, or approaching an anchorage where local knowledge is not available. The leadsman must be trained and experienced in order to get accurate readings. Also, the ship's speed must be reduced so that the sounding lead has time to sink to the bottom before the ship moves beyond the lead line. The sounding lead has a hollowed end for retrieving samples of the bottom. Tallow or saltwater soap is loaded into the hollow and picks up sediment when placed on the bottom. Paragraph 581-2.6.2 describes the lead lines currently in use by the Navy.

581-2.6.2 HAND LEAD. The hand lead consists of a rope, marked to a depth of 25 fathoms, and a 7- or 14-pound lead weight (MIL-W-3717). Figure 581-2-3 shows markings used on Navy standard hand lead line marking. The lead line should be measured by the leadsman before use to ensure accurate readings. The leadsman must memorize the markings as there will not be time to refer to the markings in a chart. The intermediate deep positions may be marked with pieces of string, if the leadsman so chooses.

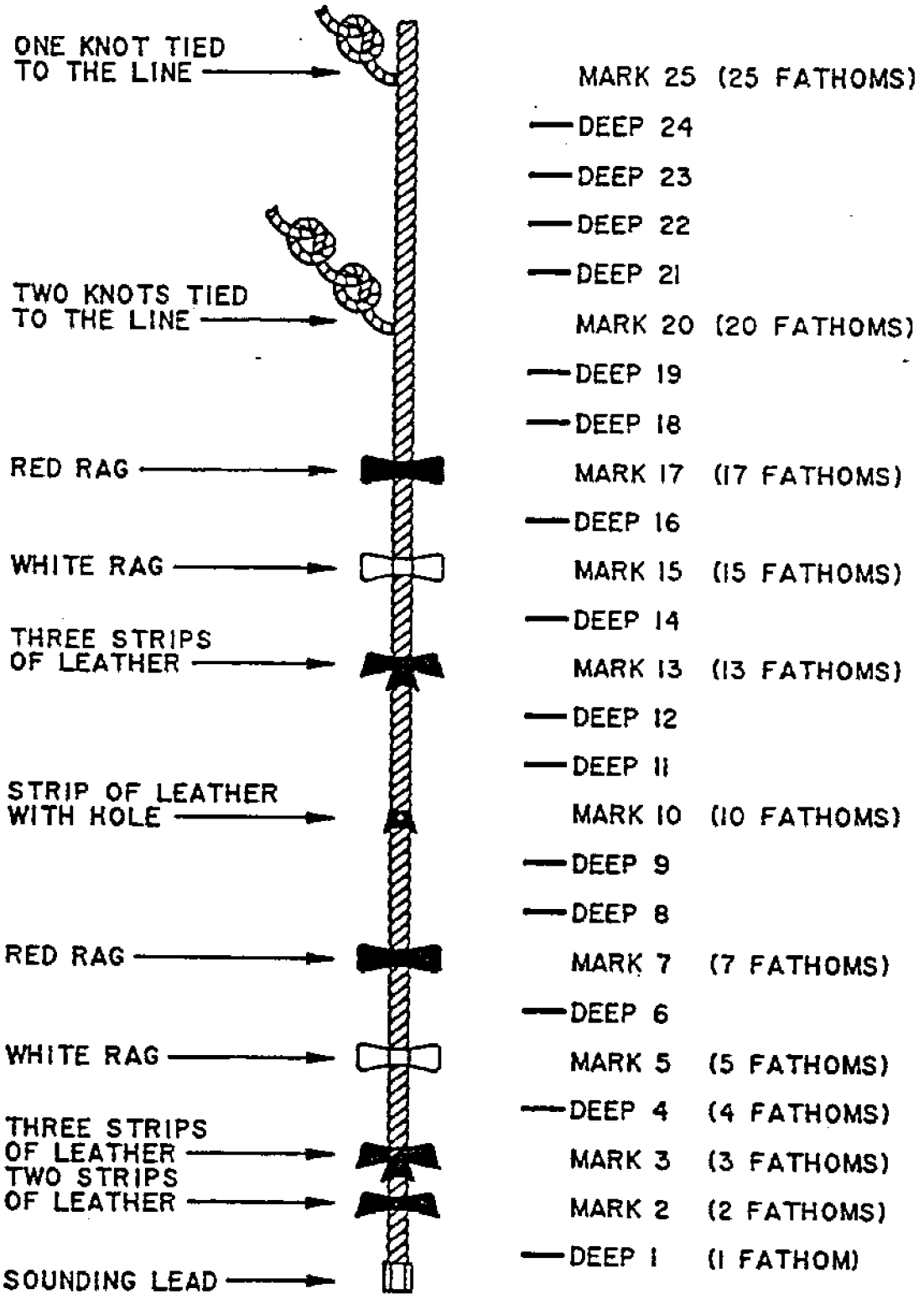


Figure 581-2-3 Hand Lead Markings

581-2.7 INSPECTION, TESTING AND MAINTENANCE

581-2.7.1 GENERAL. The maintenance, inspection and testing of ground tackle equipment is conducted in accordance with the applicable Preventive Maintenance System (PMS) and Maintenance Requirements Cards (MRC's). Maintenance, inspection and testing of the windlass, anchors, anchor chain and chain appendages are discussed in the applicable sections of this NSTM chapter.

581-2.7.2 PERIODIC MAINTENANCE. The periodicity for inspecting and preserving anchors, chain and appendages shall be in accordance with PMS and is limited to that portion of the chain which has been used for anchorage based on the ship's anchor log. Maintenance to include visual inspections of chain and detachable links, touch-up painting of the outboard swivel shot, first shot, shot markings and anchor, and lubricating of the chain stoppers and detachable links in accordance with PMS.

NOTE

Periodic maintenance is not applicable to submarine anchor and chain assemblies.

581-2.7.3 OVERHAUL MAINTENANCE. In general, all anchors, chain and appendages shall be overhauled (cleaned, inspected, and preserved) within twelve years to coincide with ship's drydocking availability.

581-2.7.3.1 If within this time period, an inspection reveals maintenance is required before the next drydocking availability, this maintenance shall be performed at the next earliest availability. Criteria for inspections are contained in GSO section 581 paragraph 581c.

581-2.7.3.2 For cases where a ship's drydocking schedule falls outside the recommended twelve year timeframe, maintenance periodicity shall be determined by ship's CMP.

581-2.7.3.3 Submarine anchor and chain overhaul maintenance periodicity shall be conducted within three years to coincide with the ship's drydocking availability.

SECTION 3.
ANCHOR WINDLASS

581-3.1 GENERAL INFORMATION

581-3.1.1 SHIPBOARD USE. Windlasses are installed on board for handling the anchor and chain used to anchor the ship and handling chain in preparation for towing. Vertical windlasses are provided with capstans and horizontal windlasses are provided with gypsy heads to handle lines for mooring and warping operations.

581-3.1.2 TYPES. There are two general types of windlasses installed on Navy ships: vertical shaft and horizontal shaft.

581-3.1.2.1 Most Navy ships are equipped with vertical shaft type windlasses as shown in Figure 581-3-1.

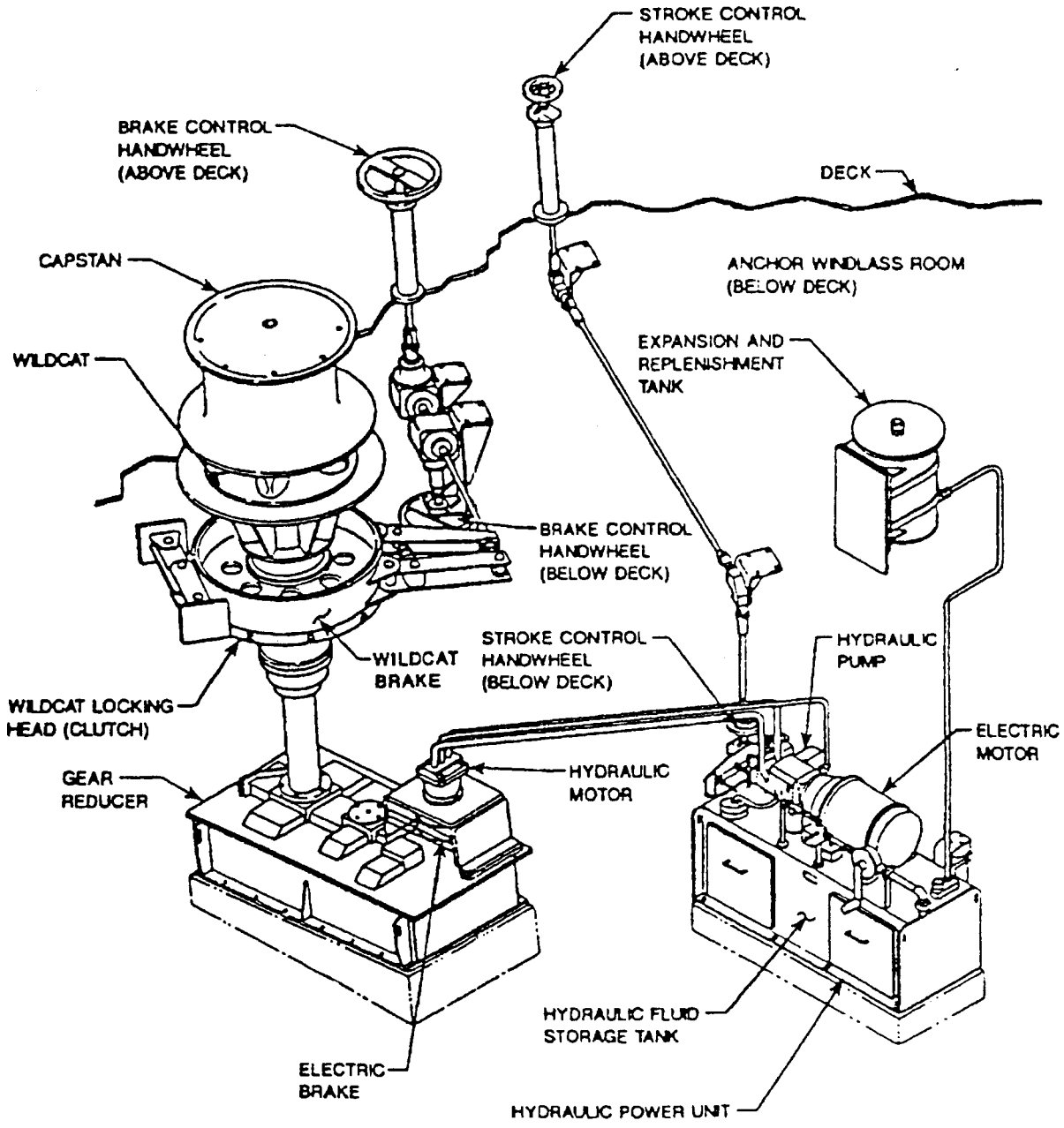


Figure 581-3-1 Vertical Shaft Type Electrohydraulic Anchor Windlass

581-3.1.2.2 Most commercial ships converted for Navy use are equipped with horizontal shaft type windlasses.

581-3.1.2.3 The vertical shaft and horizontal shaft windlass types are subdivided into groups which identify the windlass drive. These groups include the following:

a. Electrohydraulic drive

b. Electric drive

c. Steam drive

d. Hand drive.

581-3.1.3 LOCATION. Vertical shaft type windlasses are located in the bow of the ship for handling bower or keel-mounted anchors. Their power plants are located in a below-deck, weather-protected windlass room. The horizontal shaft type windlasses are located on a weatherdeck. Landing ships capable of beaching are provided with a stern anchor winch used for hauling the ship off the beach. Submarine tenders and destroyer tenders are equipped with horizontal type windlasses at the stern and are used primarily for Med or other type mooring.

581-3.1.4 REQUIREMENTS. Windlasses are designed to meet the following requirements:

a. Hoist anchor and chain from 60 fathoms (360 ft), at an average speed of six fathoms (36 ft) per minute, except the average speed for aircraft carriers is five fathoms (30 ft) per minute.

b. Hoist anchor and chain from 100 fathoms (600 ft), at no specified speed.

c. With the locking head disconnected and without additional leverage, the wildcat hand brake shall stop and hold the anchor and chain with 15 and 30 fathoms (90 and 180 ft) out, in not more than two fathoms (12 ft); with 45 fathoms (270 ft) out, in not more than three fathoms (18 ft); and, with 60 fathoms (360 ft) out, in not more than four fathoms (24 ft).

d. When capstans or gypsy heads are furnished as an integral part of the windlass, a specified rope speed and line pull on the capstan is specified in the applicable equipment technical manual.

e. Withstand a static load on the capstan or gypsy head (used as a bitt) equal to the minimum breaking strength of the specified type and size of rope applied at midheight of the head and normal to its axis.

581-3.1.5 COMPONENTS. The main components of the windlass are the electric or hydraulic brake, gear box, wildcat locking head (clutch), hand brake, wildcat, capstan and stroke control hand wheel (see Figure 581-3-1). For the vertical shaft type windlass, the wildcat and capstan are mounted on the deck above the windlass room. This is commonly a weather deck area. For the horizontal shaft type windlass, all of the components are assembled on a common bedplate on the weather deck.

581-3.1.6 STERN ANCHOR WINCHES. The details for stern anchor winches are given in the ship's specification. Equipment operating and technical manuals are furnished by the ship builder for each installation. Frequently MIL-W-15808 is referenced in the ship's specification for the stern anchor winch. Depending on ship type, the stern anchor winch uses wire rope or anchor chain for attachment to the anchor.

581-3.2 ELECTROHYDRAULIC DRIVE

581-3.2.1 GENERAL. The electrohydraulic drive converts electrical power to hydraulic power through the hydraulic power units. An electric motor is connected to a variable-stroke hydraulic pump. Piping is used to supply and return the hydraulic fluid to the hydraulic motor which together with the electric brake are coupled to the windlass gear box input shaft. The electrohydraulic drive is particularly adapted for anchor handling because of its variable speed and load capabilities. The electrohydraulic drive is used to overcome the operating limitations inherent with either steam or electric motor driven windlasses.

581-3.2.2 ELECTRIC MOTOR. The electric motor for the electrohydraulic drive is usually a single-speed, alternating current, squirrel-cage type. Electric control is provided for light-duty starting as the electric motor is

started under no-load conditions. An interlock switch is provided to prevent starting the electric motor if the hydraulic pump stroke control is not set at the off or zero stroke position.

581-3.2.3 WINDLASS SPEED. Windlass speed is determined by varying the stroke of the hydraulic pump. This is done by the stroke control handwheel located on the weather deck, and at the hydraulic pump in the windlass room. These handwheels also control the direction of rotation of the windlass and are suitably marked. The stroke at which the hydraulic pump is set determines the quantity of hydraulic fluid delivered to the hydraulic motor, which in turn determines the speed at which the hydraulic motor rotates.

581-3.2.4 HYDRAULIC POWER UNIT. Independent hydraulic power units are provided for each windlass. When there are two windlasses on a ship, the hydraulic power units are arranged port and starboard in the windlass room with the port hydraulic power unit driving the port windlass and the starboard hydraulic power unit driving the starboard windlass (see paragraph 581-3.2.6). Each hydraulic power unit is complete with electric motor, variable-stroke hydraulic pump, pressure relief valves, hydraulic fluid replenishing valves, hydraulic fluid circulating pumps, filters and breathers. Some hydraulic power units are furnished with hydraulic fluid heaters and coolers. Refer to **NSTM Chapter 556, Hydraulic Equipment (Power Transmission and Control)** for general information about hydraulic components.

581-3.2.5 EXPANSION AND REPLENISHMENT TANK. The hydraulic fluid expansion and replenishment tank is located above the highest point on the hydraulic system, usually on the underside of the main deck. Maintain the fluid level in the expansion and replenishment tank.

CAUTION

Do not operate a failed hydraulic power unit until repairs are made.

581-3.2.6 TRANSFER VALVES (CROSSOVER VALVES). In some cases, transfer valves (crossover valves) are provided in the hydraulic fluid lines which, when set according to manufacturer's instructions, allow the port hydraulic power unit to operate the starboard wildcat and the starboard hydraulic power unit to operate the port wildcat. Use transfer valves only when one of the hydraulic power units has failed.

CAUTION

If, in extreme emergency, a decision is made to cross-connect the operable hydraulic power unit with the failed windlass that contains hydraulic fluid contaminated with metallic particles, then it is almost certain that the contaminated hydraulic fluid will cause failure of the operable hydraulic power unit. The officer in charge must be informed of the consequences of this decision before the cross-connection is made.

581-3.2.7 CROSS-CONNECTING. Before cross-connecting the hydraulic power units, inspect all filters in the failed hydraulic power unit for metallic particles. Also, obtain a sample of hydraulic fluid from the storage tank and visually examine it for contamination. If metallic particles or hydraulic fluid contamination is found, do not cross-connect the hydraulic power units.

581-3.2.8 PRESSURE RELIEF VALVE. Pressure relief valves are set to prevent excessive loads from developing in the anchor chain and windlass drive components. The valves should be set in accordance with the requirements in the equipment technical manual. When housing the anchor, personnel should not rely on the pressure relief valve to prevent excessive loads. Anchors must be housed at the slowest speed possible to prevent damaging the anchor chain, windlass or possibly the loss of the anchor.

581-3.2.9 APPLICABLE SPECIFICATION. The requirements for electrohydraulic, vertical shaft windlasses, suitable for installation on Navy ships, are detailed in MIL-W-19623.

581-3.3 ELECTRIC DRIVE

581-3.3.1 AC MOTOR. The windlass electric drive is an electric motor coupled to the input shaft of the windlass speed reducer. The electric power to the motor is normally alternating current (ac). The ac motor is always reversible and has at least two speeds. The slower speed is used to house the anchor in the hawse pipe and to hoist the anchor and chain from 100 fathoms (600 feet). A slip clutch is coupled between the motor and the speed reducer to prevent developing excessive loads when housing the anchor. Set the slip clutch in accordance with the requirements in the equipment technical manual. An electric brake is keyed to the other end of the electric motor shaft.

581-3.3.2 DC MOTOR. Some ships use direct current (dc) to power the electric drives. Most power generated on ships is ac which is then changed to dc power with rectifiers. Undesirable features of the dc electric drive include the conditions that the rectification is not 100 percent efficient and the ship’s payload capacity is reduced the weight of the rectifiers. Desirable features of the dc electric drive include smoother starting characteristics and dynamic braking control for lowering the anchor. The dc motor control normally provides five speed points in each direction. This provides a lower speed when housing the anchor and more intermediate speeds for other anchor movements.

581-3.3.3 Many cargo ships, transports and auxiliary ships are provided with horizontal shaft, self-contained electric drive windlasses with the motor and gear box located on the windlass bed plate on the open deck. These windlasses have combined facilities for anchor handling and warping. They consist of two declutchable wildcats on the main shaft and one gypsy head on each end of the shaft ends, all driven through suitable speed reduction gearing by the electric motor.

581-3.4 STEAM DRIVE

581-3.4.1 Steam-powered windlasses are found on some of the older Navy ships and conversions. They are no longer used in new construction. While the steam-powered windlasses provided a good range of speeds and smooth acceleration, they were hampered by the operating and maintenance problems common to infrequently used steam-powered equipment. Most of the problems were related to corrosion and seizing. Steam-powered windlasses are the horizontal shaft type installed on a weather deck and are typically single-cylinder, horizontal engines with two furnished for each windlass. Speed control and reversing are obtained by a hand-operated control throttle valve which regulates steam flow through piston-type steam valves.

581-3.5 HAND DRIVE

581-3.5.1 Hand-drive windlasses are limited to use where the weight of the anchor and chain can be handled in a reasonable time without excessive effort. The hand-drive windlass is manually operated. No electric or hydraulic power is required for operation. These windlasses are normally horizontal shaft type installed on a weather deck. Manually operated hydraulic pumps have been fitted on some of the windlasses to handle up to 2,000-pound anchors and 1-3/8 inch chain. This is the upper limit as considerable time is required to hoist the anchor.

581-3.6 MAJOR WINDLASS COMPONENTS

581-3.6.1 Major Components. The major components of the windlass between the drive motor and the anchor chain are the electric brake, gear box, locking heads, hand brake and the wildcat. The integral capstan is a major component of most windlasses but is not required for handling the anchor or anchor chain. Aircraft carriers and submarines are examples of ships that do not have a capstan integral with the windlass.

581-3.6.2 ELECTRIC BRAKE. On electrohydraulic windlasses, the electric brake is installed between the hydraulic motor and the windlass gear box. On the electromechanical windlasses, the electric brake is installed on the electric motor shaft. The shoe-type brake consists of a drum that is attached to the gear box shaft. The brake shoes contact the outside drum surface. They are lined with a friction material and are closed against the drum with springs. Electric power is required to operate the solenoid that releases the brake shoes from the drum. The electric brake is designed to hold 150 percent of the drive motor rated torque and sets on the loss of electrical power to the windlass drive. Electric or hydraulic brakes are installed on all electrohydraulic and electromechanical drives. Steam drives may use steam pressure to release a similar brake.

581-3.6.2.1 Alternative Location. Alternative locations of the electrohydraulic windlass electric brake include being installed on either end of the electric motor on some older ships. This is not the allowed location for new ship construction. When the electric brake is installed at the alternative location, frequent inspection of the hydraulic system lines and connections for leaks is necessary. The hydraulic lock will cause the hydraulic fluid between the hydraulic pump and the hydraulic motor to escape when the hydraulic lock is required to support the anchor and chain weight.

581-3.6.3 WINDLASS GEAR BOX. The windlass gear box is typically a triple-reduction, parallel shaft, speed reducer. The speed ratio is selected to reduce the motor speed to hoist the anchor from 60 fathoms at an average speed of 6 fathoms per minute. On aircraft carriers, the average hoisting speed is reduced to 5 fathoms per minute. All bearings are antifriction. Gearing is fully enclosed in an oil-tight case and is pressure lubricated from a shaft driven or electric power driven pump. The lubricating oil circulation pump must be running any time the windlass is used. Sometimes the gearing is arranged so that splash lubrication is adequate. The gearing is designed to transmit the rated torque of the motor.

581-3.6.4 WILDCAT LOCKING HEADS. The wildcat locking head (clutch) provides for disengaging the wildcat from the windlass drive. This permits free rotation of the wildcat when dropping anchor using the hand brake. It also permits the windlass drive to rotate the capstan while the wildcat is secured by the brake. The wildcat locking head must not be engaged or disengaged when either or both the wildcat or the windlass drive is rotating. Before disengaging the wildcat locking heads, the hand brake should be set to prevent the wildcat from

rotating. The wildcat locking heads should be either fully engaged or fully disengaged. Partial engagement may damage the locking head components and may result in intermittent wildcat movements which the operator cannot control.

581-3.6.5 HAND BRAKE. Each wildcat is equipped with a hand brake that consists of an externally contracting flat band that closes on a drum. The band is lined with a friction material that is riveted to the brake shoe. The drum is keyed to the same shaft to which the wildcat is keyed. The wildcat only turns when the drum is allowed to turn. There are handwheels provided on the deck and in the windlass room to operate the hand brake. Turning either handwheel contracts or expands the brake band. For anchor chain sizes 3-1/2 inches and larger, hydraulic cylinders are used to assist in operating the hand brake. The hand brake is used intermittently to stop the wildcat when dropping the anchor. If the anchor is allowed to free fall and the hand brake fails to function, all of the anchor chain will be pulled out of the chain locker. The bitter end shackle may fail which would result in the loss of the anchor and chain.

581-3.6.6 WILDCATS. The wildcat is a special type of drum or sprocket constructed to handle the anchor chain links. The outer surface is provided with flats or pockets in which the chain links lie, flat side to the wildcat shaft. At each end of the pockets, lugs known as whelps are provided which contact the ends of the links lying flatside to the wildcat shaft. A central groove in the outer surface accommodates the links perpendicular to the wildcat shaft that are not in contact with the wildcat. The wildcat is rotated by the windlass drive to heave in or pay out the chain. The applicable specification is the American Society for Testing and Materials (ASTM) designation F765-82 which supersedes NAVSEA dwg 52601-860304. For new ship construction the Navy uses wildcats that fit anchor chain sizes in 1/8-inch increments. However, commercial ships that are converted for Navy use may be equipped with wildcats that fit 1/16-inch increment chain sizes. When necessary, replace the non-standard chain with the next larger Navy standard size.

581-3.6.7 CAPSTANS. Capstans are keyed to the drive shaft and rotate when the windlass drive is running. When using the capstan, apply the wildcat hand brake before the wildcat locking head is disengaged. The capstan will now operate independently of the wildcat. When the capstan is not being used, do not leave ropes tied on or wrapped around the capstan.

581-3.6.8 CHAIN STRIPPER. A chain stripper is a rigid structure that is attached to the deck. It extends into the wildcat groove on the side opposite where the chain contacts the wildcat. If the anchor chain pitch is less than the wildcat pitch, the anchor chain will tend to lock onto the wildcat. The chain stripper will force the chain off the wildcat.

581-3.7 GENERAL MAINTENANCE INSTRUCTIONS

NOTE

Where the Preventive Maintenance System (PMS) is installed, conduct preventive maintenance in accordance with the applicable Maintenance Requirement Cards (MRC's).

581-3.7.1 GENERAL. In addition to the maintenance instructions contained in the applicable technical manuals, observe the instructions in the following paragraphs.

581-3.7.2 DURING PERIODS OF INACTIVITY. Maintenance and adjustment of equipment should be continued even during periods when it is not in use to prevent deterioration and to provide dependable operation when required. Inspect the windlass weekly, operating as necessary to ensure the equipment is in proper condition.

CAUTION

Verify that the wildcat hand brake is set before releasing chain stoppers.

581-3.7.3 HAND BRAKES. Windlass hand brakes are designed to stop and hold the anchor and chain when paying out. In order to perform this function, the brakes must be in good condition and properly adjusted. Due to wear and compression of the brake lining, the clearance between the brake drum and band will increase after the windlass has been in operation for some time. Means of adjustment for this clearance are provided on all brakes and should be used if inspection indicates excessive clearance. Most anchor and chain losses are caused by hand brakes not holding due to lack of or improper adjustment or wear.

581-3.7.4 LUBRICATION. Lubrication instructions are provided in the technical manual and on the lubricating chart posted near the windlass machinery. Adhere to the grades of lubricant, frequency and points of application. Periodically flush the lubricant from the wildcat bushing and relubricate.

CAUTION

The wildcat locking head (clutch) must be disengaged and the chain held by setting the wildcat hand brake.

a. When the windlass has not been used for some time, lubricate before operation. Rotating the windlass by power when lubricating will help distribute the lubricant.

b. After using the windlass, lubricate the equipment to prevent rusting and freezing of adjacent parts and to protect finished surfaces from corrosion.

581-3.7.5 ELECTRIC BRAKE. Check the electric brake for proper operating adjustment and to ensure that braking surfaces are free of rust and grease.

581-3.7.6 FASTENERS. Check that foundation and holddown bolts and nuts are tight.

581-3.7.7 ELECTROHYDRAULIC WINDLASS. The hydraulic equipment used for operating the electrohydraulic windlasses are manufactured with close clearances between moving and stationary parts. To maintain these clearances and to prevent wear, it is necessary to take every precaution to keep dirt, grit and foreign material out of the hydraulic system. Use only clean hydraulic fluid for filling and replenishing the system. Use only clean hydraulic fluid containers and strain the hydraulic fluid as it is poured into the system. Interiors of valves, piping and hydraulic fluid tanks should be cleaned (before installation) to remove all sand, scale and foreign material. Fill the hydraulic system only with approved hydraulic fluid that meets the requirements in the equipment technical manual. The seal and gasket material selections are based on the hydraulic fluid. If the wrong

hydraulic fluid is used, the seals may swell or rapidly deteriorate and cause the windlass drive to fail. When ordering replacement hydraulic components, always specify the type of hydraulic fluid used in the system.

581-3.7.7.1 Releasing Entrapped Air. Hydraulic systems, as installed on windlasses, perform best when free of entrapped air which usually enters when filling the system with hydraulic fluid. The presence of air is indicated by noisy operation or by speed variation, especially the slowing down under load. Air vent needle valves are provided at high points on the piping. When filling the system, these valves should be used to allow the escape of air by manipulating the valve until clear hydraulic fluid is observed. A few turns of the hydraulic pump by power will force the air out of the cylinders and valve plate ports. Opening air valves at high points will also allow the air to escape. If there are still indications of air in the system, operate the hydraulic system for about twenty minutes at reduced stroke and high pressure. If this does not force the air out of the active system, discontinue operation and troubleshoot to find source of problem.

581-3.7.7.2 Setting Pressure Relief Valves. Pressure relief valves are provided in the hydraulic piping to prevent excessive force on the chains and windlass driving mechanism. Adjust these valves to the recommended setting in the ship's technical manual. Observe system pressure gauges while the hydraulic power unit 15 operating to determine if the hydraulic pressure is exceeding the pressure relief valve setting. The highest pressure reading will probably occur when housing the anchor or starting to hoist the anchor. If the pressure relief valve feels hot to the touch or is noisy, there may be something preventing the pressure relief valve from seating. The valve should be replaced or repaired.

581-3.7.8 STEAM WINDLASS. Steam windlasses are not designed to operate on full boiler pressure. The rated capacity of the windlass is based on a 100 or 125 psig steam pressure, controlled by a pressure regulator in the steam line. Check that the regulator is in proper condition and that the rated steam pressure is maintained.

581-3.7.8.1 If the windlass has not been used for some time, the parts should be lubricated before operation. See the technical manual for details.

581-3.7.8.2 Before operating the windlass, drain the cylinders, control valves, steam chests and piping.

581-3.8 INSPECTION AND TESTING

581-3.8.1 GENERAL. Complete all inspections, repairs and adjustments prior to conducting drop tests. Conduct these tests by or under the direction of experienced personnel from the repair activity. Drop tests are hazardous and can result in the loss of ground tackle. Do not allow more than 15 fathoms (90 ft) of chain to run free without stopping. Observe the 65 fathom (390 ft) maximum depth for the drop test. Observe all safety precautions and clear the area of personnel not involved with the drop test.

581-3.8.2 TEST AFTER REPAIR. Have the shipyard or repair activity test the anchor windlasses after overhaul or major repairs to verify that the windlass has been fully restored to service. Minor repairs and adjustments, not involving repair or replacement of structural members, brake mechanism or drive components, do not require retesting of the windlass. The tests should be the same as specified for contract acceptance of the particular ship. Always check the electric brake operation on electrohydraulic drives because the windlass can be stopped by hydraulic lock and it will appear that the electric brake stopped the windlass. The normal internal leakage of hydraulic components will cause a slow loss of the hydraulic lock and the windlass will begin to creep after a short time. If the electric motor stops for any reason and the electric brake is closed, apply the wildcat hand brake immediately.

581-3.8.3 PERIODIC TESTS. These tests, prescribed by applicable PMS requirements, are to be made by ship's force on a yearly basis and may also be required during Underway Material Inspections. These tests may also be used, at the option of the ship, after replacement or adjustment of brake linings. Tests may be conducted in conjunction with a regular ship anchoring evolution. Tests include a no-load running test to verify proper functioning of controls and drive components, a drop test and recovery to test the hand brake and wildcat drive, and an electric brake functional test. Periodic tests to be made by ship's force are less severe than tests to be conducted by repair activities. This reduces danger to personnel and avoids jeopardizing the ship's mission due to ground tackle loss.

CAUTION

Stop the pressure relief valve testing if any chain movement or wildcat rotation is noticed.

581-3.8.4 PRESSURE RELIEF VALVE TESTING (WITHOUT REMOVAL FROM HYDRAULIC SYSTEM). If the pressure relief valve (PRV) is removed from the hydraulic system for testing and adjustment, air and dirt may enter the hydraulic system. When the PRV is replaced, the air can be bled from the system, but there is always a question as to whether the dirt was filtered from the hydraulic fluid before the hydraulic components were damaged. To verify that the PRV is adjusted to the proper setting without removing it from the system:

1. Place hydraulic pump stroke controls on neutral (zero-stroke).
2. Start main hydraulic pump electric motor.
3. Engage wildcat locking head.
4. Rotate wildcat to provide slack in the anchor chain between the wildcat and the chain stopper.
5. Pull the anchor chain away from the wildcat and secure.
6. Set the wildcat hand brake as tight as possible.
7. Adjust the electric brake so that the solenoid does not release the brake shoes from the brake drum.
8. Turn the hydraulic pump stroke control handwheel to the shortest stroke (slowest speed) available.
9. Observe the hydraulic system pressure gauge.
10. If the hydraulic system pressure exceeds the PRV set point or the hydraulic system pressure never reaches the PRV set point, turn the hydraulic pump stroke control handwheel to neutral (zero-stroke).
11. Adjust the PRV as required and retest per previous 8, 9, and 10.
12. If the PRV does not respond to the adjustments, it must be replaced. Skip step 13 and proceed with step 14.
13. If the PRV responds to the adjustment, continue the adjustment until the PRV releases the hydraulic pressure at the desired set point.
14. Turn the hydraulic pump stroke control handwheel to neutral (zero-stroke).
15. Disengage the wildcat locking head.
16. Adjust the electric brake so that the solenoid releases the brake shoes from the brake drum.
17. Turn off the main hydraulic pump electric motor.
18. Remove the restraints from the anchor chain so that the anchor chain is engaged with the wildcat.

581-3.8.5 CHAIN STOWAGE CAPACITY. After the initial sea trials, confirmation of the chain stowage capacity in the chain locker will only be done in drydock or at pierside.

SECTION 4.
ANCHORS

581-4.1 GENERAL INFORMATION

581-4.1.1 LOCATION. Anchors are defined by their location or function as follows:

a. Bower anchors are carried on the bow, usually in hawse pipes with deck and shell bolsters or deck edge bolsters that normally accommodate lightweight type (LWT) anchors.

b. Stern anchors are carried on the stern.

c. Keel anchors are housed within the hull of the ship or submarine, near the keel, in shell type housing pockets. A ball guide fitting above the anchor shank is equipped with projections that orient the anchor, by cam action, into the anchor housing pocket in the hull as the anchor is housed.

581-4.1.2 ANCHOR SIZE. Anchor size is expressed in terms of the weight of the anchor in pounds. The anchor holding power ratio is the ratio of the anchor holding power, in pounds, to the anchor weight, in pounds, and varies between anchor types.

581-4.1.3 ANCHOR SHACKLE. The anchor shackle is furnished with the anchor in accordance with the applicable anchor specification and drawing. The anchor shackle pin can be tack welded, both sides to the shackle, to prevent the pin from backing out.

581-4.2 ANCHOR TYPES

581-4.2.1 GENERAL. Three designs of stockless anchors are used on Navy ships. All three designs are illustrated in Figure 581-4-1. There is no stock in the shank of a stockless anchor. Because the center of gravity of the flukes is above the pivot in the crown, the flukes will not stay upright when the anchor is suspended.

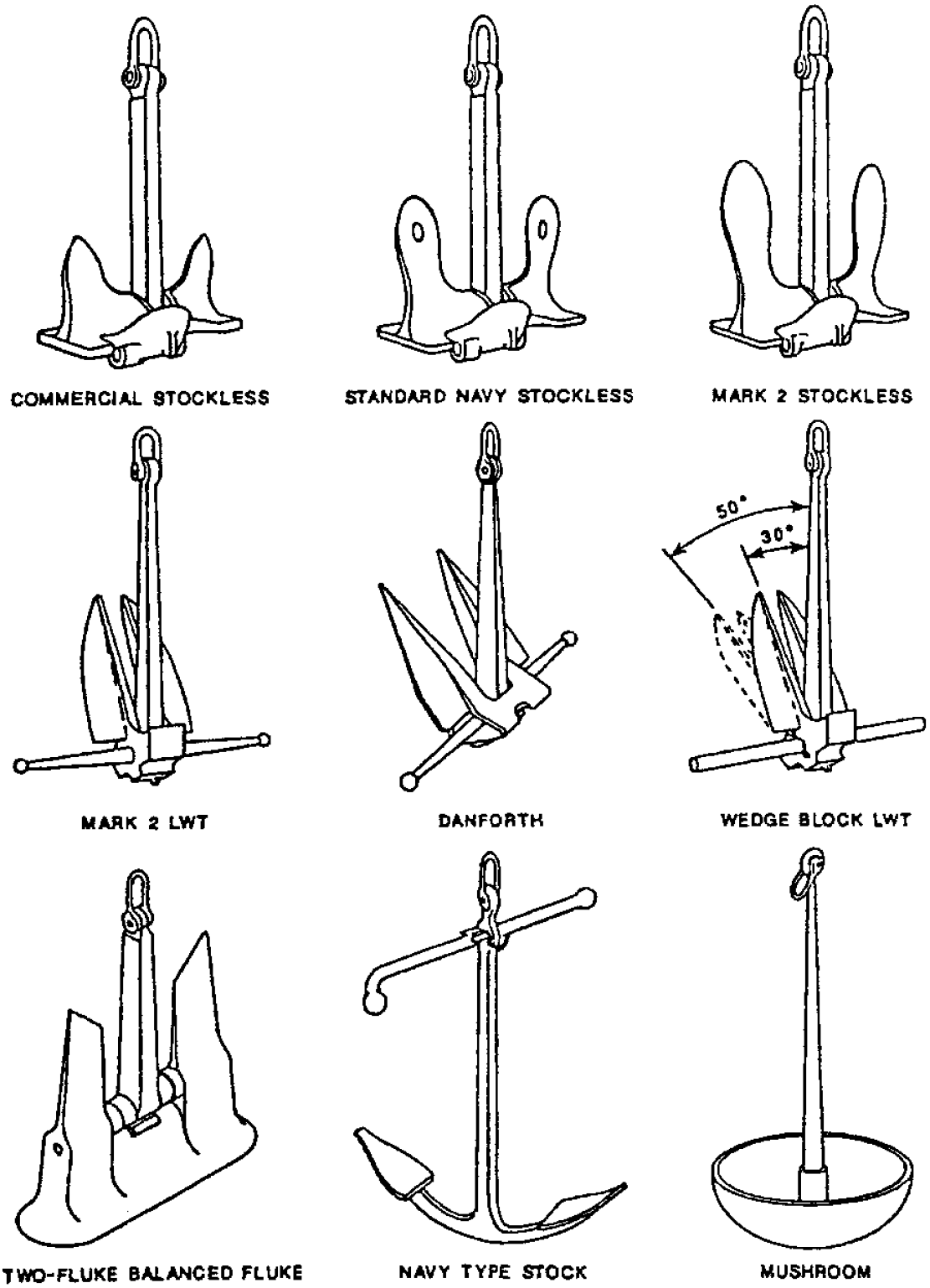


Figure 581-4-1 Types of Anchors

581-4.2.2 COMMERCIAL STOCKLESS. Commercial stockless anchors have the shortest flukes and the least holding power of the stockless anchors for a given weight. They are commonly found on commercial ships which have been converted to Navy use.

581-4.2.3 STANDARD NAVY STOCKLESS. Standard Navy stockless anchors (D0D-A-24581 and NAVSHIPS dwg 803-860337) have longer flukes than the commercial stockless anchor and, for the same size of anchor, more holding power. Typically the anchor holding power for standard Navy stockless anchors is 7.1 times the anchor weight as shown in Table 581-4-1.

581-4.2.4 MARK 2 STOCKLESS. The 60,000-pound Mark 2 stockless anchor (D0D-A-24581 and NAVSHIPS dwg 803-920808), used on aircraft carriers, has the longest flukes of the stockless anchors and an anchor holding power to weight ratio of 9.1, with a holding power of 546,000 pounds.

581-4.2.5 LIGHTWEIGHT. Two designs of lightweight type (LWT) anchors are used on Navy ships. Both designs are illustrated in Figure 581-4-1. Sizes below 150 pounds are commonly used as boat anchors (see Table 581-4-2 and Table 581-4-3).

581-4.2.6 MARK 2 LWT. The Mark 2 LWT anchor (DOD-A-15707 and NAVSHIPS dwg 803-632566) has high holding power for its weight. As an example, a 10,000-pound Mark 2 LWT anchor has approximately the same holding power in a firm sand bottom as the 22,500-pound standard Navy stockless anchor. The anchor holding power for Mark 2 LWT anchors is shown in Table 581-4-2.

581-4.2.7 DANFORTH. The Danforth anchor is a commercially available anchor that is similar to the Navy Mark 2 LWT. It is shown in Figure 581-4-1 for comparison. No military specifications or Navy drawings exist for Danforth anchors.

Table 581-4-1 ANCHOR HOLDING POWER FOR STANDARD NAVY STOCKLESS ANCHORS

Anchor size (pounds)	Holding power (pounds)
100	710
200	1420
300	2130
400	2840
500	3550
600	4260
700	4970
800	5680
900	6390
1000	7100
1100	7810
1200	8520
1300	9230
1400	9940
1500	10,650
1600	11,360
1700	12,070
1800	12,780

Table 581-4-1 ANCHOR HOLDING POWER FOR STANDARD NAVY

STOCKLESS ANCHORS - Continued

Anchor size (pounds)	Holding power (pounds)
1900	13,490
2000	14,200
2200	15,620
2500	17,750
3000	21,300
3500	24,850
4000	28,400
5000	35,500
6000	42,600
7000	49,700
8000	56,800
9000	63,900
10,000	71,000
11,000	78,100
12,000	85,200
13,000	92,300
14,500	102,950
15,000	106,500
16,000	113,600
18,000	127,800
20,000	142,000
22,500	159,750
25,000	177,500
30,000	213,000
35,000	248,500
40,000	284,000
45,000	319,500

581-4.2.8 WEDGE BLOCK LWT. The wedge block LWT anchor (MIL-A-24280 and NAVSHIPS dwg 805-2482962) differs from the Mark 2 LWT anchor in that it has wedge block adapters installed in the crown. When installed, the wedge blocks give an angle of 30 degrees between the shank and the flukes. When removed, the angle between the shank and the flukes increases to 50 degrees. The 50-degree fluke angle has higher holding power in mud and the 30-degree fluke angle has a higher holding power in firm sand. The anchor holding power for wedge block LWT anchors is shown in Table 581-4-3.

581-4.2.9 TWO-FLUKE BALANCED FLUKE. Two-fluke balanced fluke anchors (DOD-A-24582 and NAVSHIPS dwg 803-5000920) are used for anchoring some surface ships. Similar two-fluke balanced fluke anchors are used on the newer class of submarines. They are normally housed in the bottom of the ship or submarine. The flukes of a balanced fluke anchor are always in a vertical position when the anchor is suspended by the anchor chain. A ball guide is attached to the anchor and is equipped with projections that orient the anchor by a cam action that guides the anchor into the shell bolster. These anchors are used on surface ships in place of bower anchors where the ship's conventional anchors interfere with the ship's sonar dome when lowering or in-hauling. When a two-fluke balanced fluke anchor is housed above the waterline, holes are provided in the bottom plate of the flukes to drain water from the anchor. Typically the anchor holding power for a two-fluke balanced fluke anchor is nine times the anchor weight as shown in Table 581-4-4.

581-4.2.10 NAVY TYPE STOCK. Navy type stock anchors, in sizes below 150 pounds, are used chiefly as boat anchors. Navy type stock anchors are also used for kedging and for anchoring on hard, rocky bottoms. A variation of this anchor, with only one fluke, was used as an ice anchor by the Navy. The Navy type stock anchor is sometimes referred to as an old-fashioned anchor.

581-4.2.11 MUSHROOM. Mushroom anchors (MIL-A-58005) are mushroom-shaped with a shank projecting from the center of the cupped side and were used by some older submarines for anchoring. They are also used for special purposes, as with buoys and torpedo testing barges.

581-4.2.12 FOUR-FLUKE. Four-fluke anchors are used on older submarines and are not presently used in new construction. The four-fluke anchor design is illustrated in Figure 581-4-2. There are no NAVSEA standard drawings or military specifications for the four-fluke anchors.

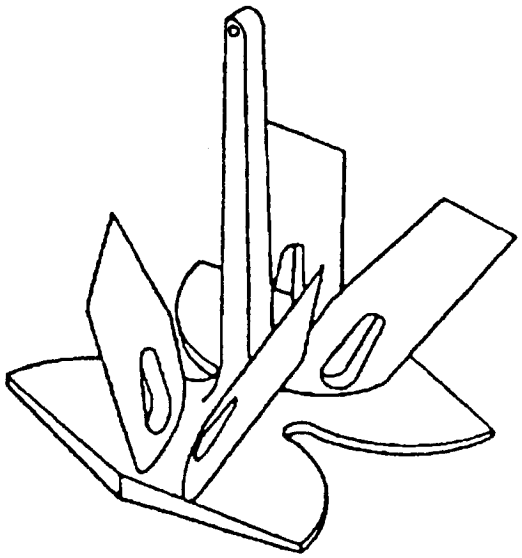


Figure 581-4-2 Four-Fluke Anchor

Table 581-4-2 ANCHOR HOLDING POWER FOR MARK 2 LWT ANCHORS (30 DEGREE FLUKE ANGLE)

Anchor size (pounds)	Holding power (pounds)
8	376
16	727
30	1300
50	1970
75	2690
100	3420
150	4600
200	5940
300	8180
500	12,500
750	18,180
1000	21,500
1500	32,700
2000	40,000

Table 581-4-2 ANCHOR HOLDING POWER FOR MARK 2 LWT ANCHORS (30 DEGREE FLUKE ANGLE) - Continued

Anchor size (pounds)	Holding power (pounds)
2500	50,050
3000	60,000
4000	75,076
5000	91,000
6000	106,747
10,000	163,500
13,000	209,000

Table 581-4-3 ANCHOR HOLDING POWER FOR WEDGE BLOCK LWT ANCHORS (30 OR 50 DEGREE FLUKE ANGLE)

Anchor size (pounds)	Holding power (pounds)
6000	106,747
10,000	163,500
14,000	204,000
16,000	233,000
20,000	290,000
25,000	364,282
30,000	434,000

Table 581-4-4 ANCHOR HOLDING POWER FOR TWO-FLUKE BALANCED FLUKE ANCHORS

Anchor size (pounds)	Holding power (pounds)
660	5940
925	8325
1985	17,865
2800	25,200
4600	41,400
6000	54,000
8000	72,000
8930	80,370
10,000	90,000
11,600	104,400
13,200	118,800
15,200	136,800
17,200	154,800
19,200	172,800
21,800	196,200
22,500	202,500
24,500	220,500
27,550	247,950
30,400	273,600

581-4.2.13 NONMAGNETIC. Nonmagnetic anchors are lightweight type (LWT) anchors fabricated with Had-

field manganese steel and other nonmagnetic materials (see DOD-A-17254 and NAVSHIPS dwg 803-632566). They are used on minesweepers whose components are required to be nonmagnetic as the ship's magnetic signature is critical to the ship's mission.

581-4.3 STORAGE

WARNING

Do not leave the anchor in a standing position with the flukes or shank upright. The standing anchor will fall over without warning and cause bodily injury. The flukes and shank shall be supported on the deck or ground and shall be blocked in place.

581-4.3.1 Anchors to be stored in the open shall be painted with two coats Epoxy Polyamide, green primer, Formula 150 per MIL-P-24441, two mils dry film thickness each coat. Store anchors with the shank, flukes and crown firmly supported on the ground as shown in Figure 581-4-3. Use adequate materials to block the anchor so that it does not move when placed in storage. Similar precautions are mandatory when shipping anchors or moving anchors about the repair and maintenance facility.

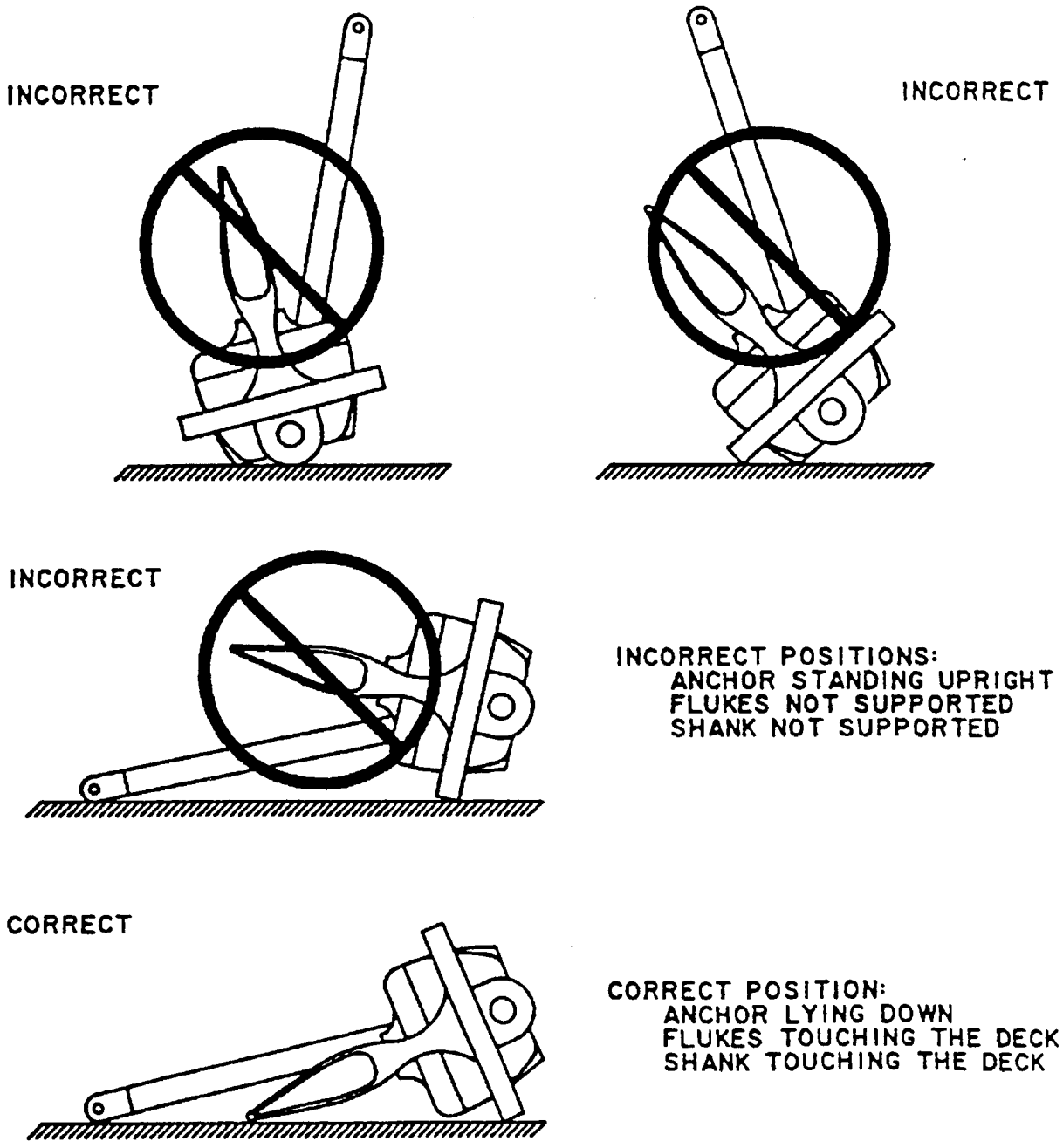


Figure 581-4-3 Anchor Storage Position

581-4.3.2 Anchor repairs shall be in accordance with the General Specification for Overhaul of Surface Ships (GSO).

581-4.4 MARKINGS

581-4.4.1 Anchors are marked with the type, weight of the anchor in pounds, year of fabrication, serial number (supplied by the manufacturer) and the letters U.S.N. These markings normally appear on the crown surfaces. The anchor may also be marked with the name of the manufacturer or commercial name of the anchor.

581-4.5 PAINTING

581-4.5.1 Anchors shall be cleaned of all foreign matter or sand-blasted, if required, and painted with two coats, Epoxy Polyamide, green primer, Formula 150 per MIL-P-24441, three mils dry film thickness each coat and two coats, Silicone Alkyd, haze gray, color 26270, 1.5 mils dry film thickness each coat in accordance with DOD-E-24635 for overhaul, maintenance or touch-up. If the anchor cannot be final painted after cleaning, a one-mil thick dry film coat of Formula 150 per MlL-P-24441 shall be applied to prevent flash rusting. Anchors housed below the waterline shall be painted in accordance with the normal underwater hull anti-corrosion and anti-fouling system.

SECTION 5.
ANCHOR CHAIN

581-5.1 GENERAL INFORMATION

581-5.1.1 BACKGROUND. There are several types of anchor chain used on Navy ships. The types which were used, and in some cases are still in use, are:

a. Forged mild steel, stud-link chain with forge-welded links.

b. Cast steel stud link chain with integral studs.

c. Submerged-arc-welded, atomic hydrogen-welded, and die-forged carbon and alloy steel stud-link chain.

d. Die-lock stud link chain in standard, high-strength and heavy-duty types.

581-5.1.2 LINK SIZE. All Navy anchor chain is made to the standard link dimensions given in the applicable specifications. The link or chain size refers to the nominal diameter of the link material in the grip area. The grip is the area where the adjacent links make point contact with each other when the anchor chain is in tension. The link length is six times the nominal diameter and the link width is 3.6 times the nominal diameter. The nominal diameter is sometimes referred to as the bar diameter or wire diameter.

581-5.1.3 STUD. All Navy anchor chain is made with a stud and is commonly called stud-link anchor chain. The stud is the bar that holds the two sides of the link apart. Stud-link chain does not stretch as much as chain without studs in the links. The link length is critical to the wildcat fit and it is important that the stud is in the link to maintain link width and length.

581-5.1.4 SHOT LENGTH. Chain for Navy use is procured in shot lengths of 15 fathoms (90 feet). The exact number of links in a shot for each chain size (die-lock and flash-butt-welded chain) is shown in Table 581-5-1. There must always be an odd number of links in a shot of chain so that all detachable links are placed in the same position on the wildcat. The shot length consists of all common links.

581-5.1.4.1 Detachable Link Positioning. The detachable link is positioned with the flat side perpendicular to the wildcat shaft with the lead plug and pin of detachable link facing outboard (shown in figure in ASTM F765-93). This requires the flat side of the link at each end of a shot of chain to be parallel to the wildcat shaft (riding in a pocket) during shot assembly.

581-5.1.5 MANUFACTURING AND REPAIRING CHAIN. No activity is authorized to repair chain without prior approval of the Naval Sea Systems Command (NAVSEA). No welding of any type is allowed.

581-5.1.6 HEAT TREATMENT. All anchor chain is heat-treated and proof load tested by the chain manufacturer. It is not necessary for any other activity to proof load test the chain after it is received by the Navy. Chain should not be shipped for subsequent heat treatment without authority from NAVSEA.

581-5.1.7 CARE TO PREVENT BENDING CHAIN. When using anchor chain do not subject it to short bends. Take care to ensure that the anchor chain is not subjected to bending of the type that may occur when the chain is lying across a ship's stem, the chain is roved through a buoy ring, or passed over a small radius bolster. Chain loses strength when subjected to transverse bending. This is especially true in the case of detachable links. All past anchor chain systems were designed so that the chain should not pass over any curvature that allows less than three continuous link contact. New ship designs require a minimum bend radius of seven times the nominal chain diameter. For example, the minimum bend radius for 3-1/2 inch chain is 24.5 inches.

Table 581-5-1 PHYSICAL REQUIREMENTS, WEIGHT AND NUMBER OF LINKS PER SHOT FOR STANDARD AND HEAVY-DUTY DIE-LOCK CHAIN

Size of [1] chain (inches)	Physical Requirements		Weight (pounds per shot)	No. of links per shot
	Proof load (pounds)	Minimum breaking load (pounds)		
3/4	48,000	75,000	490	359
7/8	64,000	98,000	680	305
1	84,000	129,000	890	267
1-1/8	106,000	161,000	1130	237
1-1/4	130,000	198,000	1400	213
1-3/8	157,000	235,000	1690	193
1-1/2	185,000	280,000	2010	177
1-5/8	216,000	325,000	2325	165
1-3/4	249,000	380,000	2695	153
1-7/8	285,000	432,000	3095	143
2	289,800	439,200	3490	135
2-1/8	325,800	493,200	3935	125
2-1/4	362,700	549,000	4415	119
2-3/8	402,300	607,500	4915	113
2-1/2	442,800	669,600	5475	107

Table 581-5-1 PHYSICAL REQUIREMENTS, WEIGHT AND NUMBER OF LINKS PER SHOT FOR STANDARD AND HEAVY-DUTY DIE-LOCK CHAIN - Continued

Size of [1] chain (inches)	Physical Requirements		Weight (pounds per shot)	No. of links per shot
	Proof load (pounds)	Minimum breaking load (pounds)		
2-5/8	486,000	731,700	6050	101
2-3/4 STD	531,000	796,500	6660	97
2-3/4 HD	584,100	882,900	7000	97
2-7/8	576,000	868,500	7295	93
3 STD	623,700	940,500	7955	89
3 HD	685,800	1,035,000	8100	89
3-1/8	673,200	1,015,200	8700	87
3-1/4	723,700	1,089,000	9410	83
3-3/8	776,000	1,166,400	10,112	79
3-1/2 STD	829,800	1,244,800	10,900	77
3-1/2 HD	972,000	1,530,000	12,000	77
3-3/4	1,008,000	1,575,000	12,500	71
4-3/4	1,700,000	2,550,000	20,500	57

[1]STD refers to standard chain and HD refers to heavy-duty, die-lock chain.

581-5.2 TYPES OF ANCHOR CHAIN

581-5.2.1 FORGE-WELDED. Forge-welded anchor chain was commonly made in the early 1900's and no longer exists on Navy ships. The links were made by tapering the ends of the steel bars by scarfing or by hammering the ends to produce a tapered length. The length of the scarf was usually not less than two times the bar diameter. The bars were heated and formed to the link shape. The scarfed areas overlapped each other. The lap was fire-welded by a forge (blacksmith). The lap was normally in the link grip area. The stud was forged in place after the link was fire-welded. Forge-welded anchor chain was expensive to make and quality control was difficult to maintain.

581-5.2.2 CAST STEEL. Cast steel anchor chain (MIL-C-21574) was made as a replacement for forge-welded chain. The stud was cast as an integral part of the link. Each common link in a shot is identical. The tensile strength of cast chain was about 30 percent greater than the forge-welded chain. Large quantities of cast steel anchor chain were purchased during World War II primarily due to a lack of manufacturing capacity to produce die-lock anchor chain. Cast steel anchor chain should be replaced, as required, with flash-butt-welded or, if available, die-lock anchor chain.

581-5.2.3 WELDED FORGINGS. Several methods have been used over the years to weld forgings together to make a type of high-strength anchor chain. In one method, the chain is made up of solid forged links joined together with hand-welded links. Sometimes the welded links were reforged to give the appearance of all solid forged links. In another method, each link consisted of two forgings that were hand-welded together. Sometimes the welded link consisted of a C-shaped end and a D-shaped end joined together. At other times the welded link

consisted of two C-shaped ends joined together with the stud hand-welded in place. The welded forging chain was expensive to make and quality control was difficult to implement on all of the hand welding.

581-5.2.4 DIE-LOCK. Die-lock chain, presently installed on many ships, was specified extensively by the Navy and was preferred to other types of chain. The last die-lock chain was produced about 1985. Replacement of die-lock chain will be flash-butt-welded chain, per paragraph 581-5.2.5. The die-lock chain was made from two alloy steel forgings. The one forging was C-shaped with the ends ribbed. The ribbed ends, due to their shape, were called Christmas trees. The other forging was D-shaped with holes pierced in each end. The Christmas trees were pushed into the holes in each end of the D-shape. The D-shape was hot forged onto the Christmas trees which formed the lock that joined the two forgings together. The stud was an integral part of the forged D-shape but was split through the center. Die-lock chain was manufactured in three types:

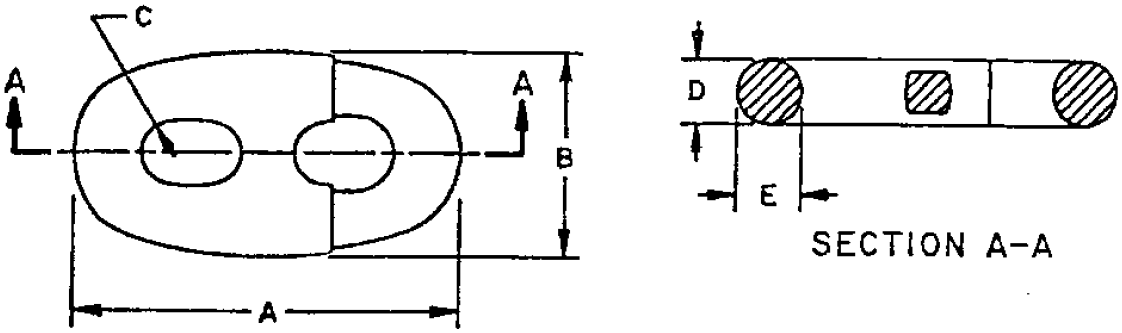
1 Type I - Standard

2 Type Il - Heavy-duty

3 Type III - High-strength.

All three types are covered in MIL-C-19944. Types I and II are shown on NAVSHIPS dwg 803-860341 and Type III on NAVSHIPS dwg 805-2137659. Table 581-5-1 shows the number of links per shot for Type I, II and III chain.

581-5.2.4.1 Type I - Standard. Standard die-lock chain is known as Type I per MIL-C-19944. It was made in 3/4 to 4-3/4 inch sizes. The physical requirements for proof load test and minimum break test loads are shown in Table 581-5-1. These are the values used by the manufacturers for testing when they made die-lock chain. The nominal weight of standard die-lock chain is also shown in Table 581-5-1. The major link dimensions are illustrated in Figure 581-5-1.



Size of[1] chain (inches)	Dimension (inches)				
	A	B	C	D	E
3/4	4-1/2	2-11/16	1/2	3/4	3/4
7/8	5-1/4	3-1/8	9/16	7/8	7/8
1	6	3-19/32	21/32	1	1
1-1/8	6-3/4	4-5/64	3/4	1-1/8	1-1/8
1-1/4	7-1/2	4-1/2	13/16	1-1/4	1-1/4
1-3/8	8-1/4	4-15/16	7/8	1-3/8	1-3/8
1-1/2	9	5-3/8	1	1-1/2	1-1/2
1-5/8	9-3/4	5-7/8	1-1/16	1-5/8	1-5/8
1-3/4	10-1/2	6-5/16	1-5/32	1-3/4	1-3/4
1-7/8	11-1/4	6-3/4	1-7/32	1-7/8	1-7/8
2	12	7-3/16	1-5/16	2	2
2-1/8	12-3/4	7-21/32	1-13/32	2-1/8	2-1/8
2-1/4	13-1/2	8-1/8	1-15/32	2-1/4	2-1/4
2-3/8	14-1/4	8-9/16	1-9/16	2-3/8	2-3/8
2-1/2	15	9	1-21/32	2-1/2	2-1/2
2-5/8	15-3/4	9-7/16	1-23/32	2-5/8	2-5/8
2-3/4 STD	16-1/2	9-7/8	1-13/16	2-3/4	2-3/4
2-3/4 HD	16-1/2	9-7/8	1-13/16	2-7/8	2-3/4
2-7/8	17-1/4	10-3/8	1-7/8	2-7/8	2-7/8
3 STD	18	10-13/16	1-31/32	3	3
3 HD	18	10-13/16	1-31/32	3-3/16	3
3-1/8	18-3/4	11-1/4	2-1/32	3-1/8	3-1/8
3-1/4	19-1/2	11-11/16	2-1/8	3-1/4	3-1/4
3-3/8	20-1/4	12-1/8	2-1/4	3-3/8	3-3/8
3-1/2 STD	21	12-1/2	2-5/16	3-1/2	3-1/2
3-1/2 HD	21	12-1/2	2-5/16	3-13/16	3-1/2
3-3/4	22-1/2	13-1/2	2-7/16	3-3/4	3-3/4
4-3/4	28-1/2	17-1/8	3-1/8	4-3/4	4-3/4

[1] STD refers to standard die-lock chain and HD refers to heavy-duty die-lock chain.

Figure 581-5-1 Dimensions for Standard and Heavy-Duty Die-Lock Chain Links

581-5.2.4.2 Type II - Heavy-Duty. Heavy-duty, die-lock chain is known as Type II per MIL-C-19944. It was made in three link sizes 2-3/4, 3- and 3-1/2 inches. The end sections, where the link grips the adjacent link, are oval in cross section. The physical requirements and weights are shown in Table 581-5-1. The major link dimensions are shown in Figure 581-5-1. The heavy-duty die-lock chain required heat treatment by the manufacturer.

581-5.2.4.3 Type III - High-Strength. High-strength, die-lock chain is known as Type III per MIL-C-19944. It was made in six link sizes --3/4-, 1-, 1-1/8, 1-3/8, 1-1/2 and 1-5/8 inches. The end sections, where the link grips the adjacent links, are circular. The high-strength link is thicker at the center of the link where the D-shaped end is forged onto the C-shaped ribbed ends. The dimensions for high-strength die-lock chain links are shown in Figure 581-5-2. The physical requirements and weights are shown in Table 581-5-2. The high-strength die-lock chain required heat treatment by the manufacturer.

581-5.2.4.4 Nonmagnetic Die-Lock. Nonmagnetic die-lock chain was made from Hadfield manganese steel for use on minesweepers. It was manufactured per MIL-C-18096 and was made in two sizes 3/4- and 1-1/8 inch. It was procured in the 1-1/4 inch chain size by a technical specification (NAVSEA 803-5959190) for use on the Avenger Class of MCMs (Mine Countermeasure ship). The physical requirements and weights are shown in Table 581-5-3. The nonmagnetic, high-strength die-lock chain was made to the same dimensions as the Type III high-strength die-lock chain. These dimensions are shown in Figure 581-5-2.

581-5.2.5 FLASH-BUTT-WELDED. Flash-butt-welded (FBW) chain is the Navy standard for new ship construction. It is also used to replace condemned die-lock chain. FBW chain manufacturing and testing requirements are detailed in MIL-C-24633. The links are made from alloy steel bar stock that is slightly larger in diameter than the nominal chain size. The oversize diameter is needed to compensate for the bar stock minus tolerance and scale formed during the manufacturing and heat-treating processes. The bar is cut to length, heated, bent to form and the ends flash-butt-welded together on an automated chainmaking machine. During the forming operation, the links are interconnected before the links are closed and welded. A forged steel stud is pressed in place between the sides of the link before the next chain link is formed. During the flash-butt-welding step, a flash ring is produced at the weld. The flash ring is removed before installing the stud. After the FBW chain leaves the chainmaking machine, the stud is welded in place on the side opposite the flash-butt-weld. The chain is heat-treated, proof load tested and inspected before it is painted.

581-5.2.5.1 FBW Link Dimensions. The FBW link dimensions are shown in Figure 581-5-3. The FBW link length dimension is the same as the die-lock link length for the same size of chain. The FBW link width dimension is generally the same as the standard die-lock link width for the same size of chain. Differences exist in the link width where the 1/32- and 1/64-inch dimensions of the standard die-lock chain have been rounded to 1/16-inch dimensions. FBW links are made in 3/4- to 4-3/4 inch sizes in 1/8-inch increments.

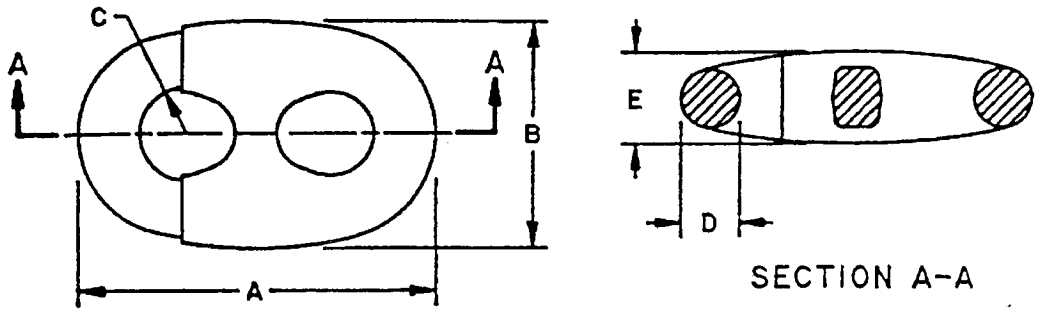
581-5.2.5.2 Physical Requirements and Weight. The physical requirements, weights and number of links per shot of FBW chain are shown in Table 581-5-4. The chain manufacturer tests all chain with proof loads before inspection. The chain is not to be proof tested after it is shipped to the Navy. Also included is the minimum break load the chain manufacturer uses to test chain samples. The minimum and maximum weight per 15-fathom (90 ft) shot is given. The weight range allows for manufacturing and material tolerances.

581-5.2.5.3 Six-Link Dimension. The chain manufacturer measures the six-link dimension of FBW chain with a tension pull applied to the chain that is equal to 10 percent of the proof load. The chain manufacturer is required to supply chain that meets the six-link dimensions shown in Figure 581-5-4. The six-link dimension is critical to the fit of the chain on the wildcat. If the fit is incorrect, the chain may lock or slip on the wildcat.

581-5.2.5.4 Nonmagnetic Flash-Butt-Welded. Nonmagnetic flash-butt-welded (FBW) chain is the Navy standard for use on minesweepers. It is used to replace condemned, nonmagnetic high-strength die-lock chain. The nonmagnetic FBW chain is made from Monel K-500 (see Project Peculiar Document NAVSEA 802-6336066) and does not require painting for corrosion protection. The chain is made in five link sizes --3/4-, 7/8-, 1-, 1-1/8 and 1-1/4 inches. The links are formed on a chainmaking machine using a process similar to that which is used to make FBW chain. The link dimensions and chain six-link dimensions are the same as the FBW chain. The nonmagnetic FBW chain stud is wider at the ends where it contacts the sides of the link than the alloy steel FBW chain stud. The wider stud ends give the nonmagnetic FBW chain a different physical appearance which aids in identification. The physical requirements and weight per shot for nonmagnetic FBW chain are shown in Table 581-5-5.

581-5.3 CHAIN IDENTIFICATION AND PAINTING

581-5.3.1 CHAIN SERIAL NUMBERS. Each shot of flash-butt-welded chain will bear the manufacturer's serial number that is stamped, cut or cast on the inner side of the end links of each shot at the time of manufacture. If one or both of these links are removed for any reason, the shot serial number and the reasons for their absence should be inserted in the ship's anchor log. The studs of all die-lock and FBW common links have U.S.N. in raised letters on one side and the chain size of the links on the reverse side.



Size of chain (inches)	Dimension (inches)				
	A	B	C	D	E
3/4	4-1/2	2-11/16	1/2	3/4	15-16
1	6	3-19/32	21/32	1	1-1/4
1-1/8	6-3/4	4-5/64	3/4	1-1/8	1-13/32
1-3/8	8-1/4	4-15/16	7/8	1-3/8	1-23/32
1-1/2	9	5-3/8	1	1-1/2	1-7/8
1-5/8	9-3/4	5-7/8	1-1/16	1-5/8	2-1/32

Figure 581-5-2 Dimensions for High-Strength Die-Lock Chain Links

581-5.3.2 CHAIN PAINT. Chains shall be cleaned of all foreign matter or sand-blasted, if required, and painted with two coats Epoxy Polyamide, green primer Formula 150 per MIL-P-24441, three mils thick each coat and two coats of Silicone Alkyd enamel, black, three mils dry film thickness each coat in accordance with DCD-E-24635, color 27038 for overhaul, maintenance or touch-up. As an alternative, FED Spec TT-V-51, black asphalt varnish two coats, three mils dry film thickness each coat, may be used in lieu of DOD-E-24635. If chain can-

not be final painted after cleaning, a one-mil thick dry film coat of Formula 150 per MIL-P-24441 shall be applied to prevent flash rusting. Submarine chain shall be painted in accordance with the normal underwater hull anti-corrosion/anti-fouling system.

581-5.3.3 SHOT MARKINGS. The detachable links and adjacent chain links are painted and marked to identify the length of chain payed out.

a. Paint chain links as follows:
   1. One link on each side of the 15-fathom (90 ft) detachable link white, FED Spec TT-E-490
   2. Two links on each side of the 30-fathom (180 ft) detachable link white.
   3. Three links on each side of the 45-fathom (270 ft) detachable link white, and so forth.

b. Paint detachable links as follows:
   1. At 15 fathoms (90 ft), red, FED Spec TT-E-489 (color 11105)
   2. At 30 fathoms (180 ft), white, FED Spec TT-E-490 3. At 45 fathoms (270 ft), blue; FED Spec TT-E-489 (color 15123) and so forth, using red, white and blue, in order.

c. Mark anchor chain with turns of wire on the studs of certain links as follows:
   1. Place one turn of wire around the stud on the first link at each side of the 15-fathom (90 ft) detachable link.
   2. Place two turns of wire around the stud on the second link at each side of the 30-fathom (180 ft) detachable link.
   3. Place three turns of wire around the stud on the third link at each side of the 45-fathom (270 ft) detachable link, and so forth.

d. Paint all of the links in the next to last shot yellow, FED Spec TT-E-489 (color 13538).

e. Paint all of the links in the last shot red, FED Spec TT-E-489 (color 11105).

f. Anchor chain markings are not required on submarines.

Table 581-5-2 PHYSICAL REQUIREMENTS AND WEIGHT PER SHOT FOR HIGH-STRENGTH DIE-LOCK CHAIN

Size of chain (inches)	Physical Requirements		Weight (pounds per shot)
	Proof load (pounds)	Minimum breaking load (pounds)	
3/4	67,500	91,100	550
1	116,100	156,700	1000
1-1/8	145,000	195,000	1270
1-3/8	211,500	285,500	1900
1-1/2	252,000	340,200	2260
1-5/8	292,500	395,000	2620

Table 581-5-3 PHYSICAL REQUIREMENTS AND WEIGHT FOR NONMAGNETIC HIGH-STRENGTH DIE-LOCK CHAIN

Size of chain (inches)	Physical Requirements		Weight (pounds per shot)
	Proof load (pounds)	Minimum breaking load (pounds)	
3/4	36,000	67,500	535
1-1/8	79,500	144,900	1218
1-1/4	97,500	178,200	1515

581-5.4 CHAIN ROTATION AND REPLACEMENT

581-5.4.1 SURVEY AND DISPOSITION. Chain, when required, will be surveyed at the naval shipyard to which it is turned in, but no disposition of it should be made until after approval by NAVSEA. The reasons for condemning anchor chain are reduced wire diameter in the grip areas of the links and/or excessive length of six-link sections, provided the chain is jumping the wildcat. Any chain which appears to have elongated or is suspect shall be measured in accordance with note 1 of Table 581-5-6. Chain diameters which are reduced to 90 percent, are considered unsuitable for further use until the particular links involved are replaced (see paragraph 581-5.4.3). If the chain jumps the wildcat during raising or lowering under power, then it is mandatory to measure the six-link dimension from every third link to determine how many six-link sections exceed the limiting dimensions per Table 581-5-6 (see note 2). If the chain is not jumping, the wildcat is satisfactory and the six-link measurement is not required. In all cases, surveys of chain should include a statement of the number of links requiring replacement and, if the chain operation on the wildcat is not satisfactory, then the number of six-link sections, whose length is in excess of the designed dimensions plus the allowable tolerance, should be indicated.

581-5.4.2 SHOT PLACEMENT AND REVERSIBILITY. Chain links and shots of chain are reversible and operate in either direction for all types of windlasses. Although the shots of chain are reversible, it is not required to end for end chain during maintenance periods. Ninety-foot shots of chain are to be connected to each other so that the connecting detachable link contacts the wildcat perpendicular to the wildcat shaft (riding in a wildcat groove). Record all changes to the onboard ground tackle in the ship's anchor log.

581-5.4.3 LINK REPLACEMENT. For in-service chain, it may be necessary to replace common links in a shot of chain if the link grip wear is excessive (see Table 581-5-6), the stud is missing or a crack is found. Link replacement within each shot to ensure that the detachable link rides in the groove, shall be as follows:

a. If a failed link, flatside perpendicular to the wildcat shaft, (riding in a groove) needs replacement, replace with a detachable link.

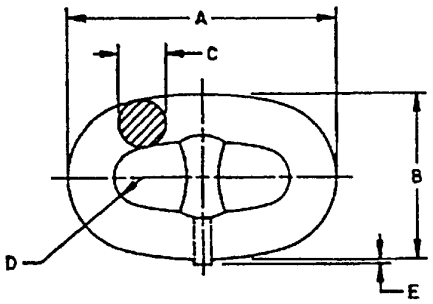
b. If a failed link, flat side parallel to the wildcat shaft, (riding in a pocket) needs replacement, remove it and one link on each side. Replace the three links with a single detachable link.

c. If a failed link is next to an existing detachable link, remove the failed link and its adjacent link. Reattach the shot to the existing detachable link. The number of links requiring replacement within a shot in excess of any combination of the above will require NAVSEA approval. Detachable links shall not be installed adjacent to each other.

581-5.4.4 DIE-LOCK CHAIN REPLACEMENT. Replace shots of condemned die-lock chain with shots of the same type, size and, if possible, strength of chain. This may not be possible because standard, heavy-duty and high-strength die-lock chain are no longer produced. Replace these types of chain with FBW anchor chain, size for size, and advise NAVSEA of the details with an immediate message. If a ship is equipped with two die-lock anchor chains, all FBW chain should replace one of the deficient die-lock anchor chains and, if applicable, those satisfactory shots of die-lock chain remaining are to replace deficient chain in the other die-lock anchor chain, as required. Any chain at or approaching maximum allowable wear should be located at the bitter end. Always check the wildcat fit and function when replacing chain. Any remaining unused chain shall be returned to the supply system. All changes shall be entered in the ship's anchor log.

581-5.4.5 SPECIAL FBW CHAIN REPLACEMENT. Special FBW chain has been fabricated from oval-shaped bar sections for all LHA's (Amphibious Helo/Landing). This was done to approximate the heavy-duty die-lock link shape and strength with a special FBW link. The special FBW link is no longer in production due to production, material and tooling costs. Replace shots of the condemned special FBW chain with shots of FBW chain, size for size, per the requirements of MIL-C-24633, and advise NAVSEA of the details by message.

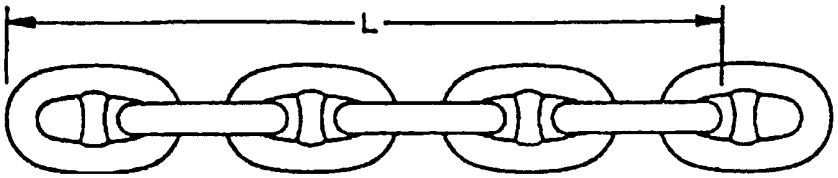
581-5.4.6 COMMERCIAL CHAIN REPLACEMENT. Certain Navy ships, built to commercial specifications, are equipped with commercial chain manufactured in 1/16-inch increments; for example, 1-13/16, 2-1/16 or 2-5/16 inches. Navy chain is manufactured in 1/8-inch increment sizes only; for example, 1-7/8, 2-1/8 and 2-3/8 inches. The wildcats of ships equipped with 1/16-inch increment sizes of chain can normally be used with a standard Navy chain that is 1/16 inch larger. Do not use a chain that is smaller than the wildcat size. For instance, a wildcat intended for 2-1/16 inch commercial chain can use a 2-1/8 inch Navy chain, but cannot be used with 2-inch Navy chain.



D = 0.65 X C
E = MAX WELD PROJECTION

Size of chain (inches)	Dimension (inches)			
	A (inches)	B (inches)	C (inches)	E (maximum)
3/4	4-1/2	2-11/16	3/4	1/16
7/8	5-1/4	3-1/8	7/8	1/16
1	6	3-5/8	1	1/16
1-1/8	6-3/4	4-1/16	1-1/8	1/16
1-1/4	7-1/2	4-1/2	1-1/4	1/16
1-3/8	8-1/4	4-15/16	1-3/8	1/16
1-1/2	9	5-3/8	1-1/2	1/16
1-5/8	9-3/4	5-7/8	1-5/8	1/16
1-3/4	10-1/2	6-5/16	1-3/4	1/16
1-7/8	11-1/4	6-3/4	1-7/8	1/16
2	12	7-3/16	2	1/16
2-1/8	12-3/4	7-5/8	2-1/8	1/16
2-1/4	13-1/2	8-1/8	2-1/4	1/16
2-3/8	14-1/4	8-9/16	2-3/8	1/16
2-1/2	15	9	2-1/2	1/16
2-5/8	15-3/4	9-7/16	2-5/8	3/32
2-3/4	16-1/2	9-7/8	2-3/4	3/32
2-7/8	17-1/4	10-3/8	2-7/8	3/32
3	18	10-13/16	3	3/32
3-1/8	18-3/4	11-1/4	3-1/8	3/32
3-1/4	19-1/2	11-11/16	3-1/4	3/32
3-3/8	20-1/4	12-1/8	3-3/8	3/32
3-1/2	21	12-5/8	3-1/2	3/32
3-5/8	21-3/4	12-15/16	3-5/8	1/8
3-3/4	22-1/2	13-1/2	3-3/4	1/8
3-7/8	23-1/4	14	3-7/8	1/8
4	24	14-3/8	4	1/8
4-1/8	24-3/4	14-7/8	4-1/8	1/8
4-1/4	25-1/2	15-5/16	4-1/4	5/32
4-3/8	26-1/4	15-3/4	4-3/8	5/32
4-1/2	27	16-3/16	4-1/2	5/32
4-5/8	27-3/4	16-5/8	4-5/8	5/32
4-3/4	28-1/2	17-1/8	4-3/4	5/32

Figure 581-5-3 Dimensions for Flash-Butt-Welded Chain Links



Size of chain (inches)	Six–link dimension L (inches)		
	Minimum	Nominal	Maximum
3/4	19-3/8	19-1/2	19-13/16
7/8	22-5/8	22-3/4	23-1/6
1	25-7/8	26	26-3/8
1-1/8	29-1/16	29-1/4	29-5/8
1-1/4	32-5/16	32-1/2	32-15/16
1-3/8	35-9/16	35-3/4	36-1/4
1-1/2	38-13/16	39	39-1/2
1-5/8	42	42-1/4	42-7/8
1-3/4	45-1/4	45-1/2	46-1/8
1-7/8	48-1/2	48-3/4	49-1/2
2	51-11/16	52	52-3/4
2-1/8	54-15/16	55-1/4	56-1/8
2-1/4	58-3/16	58-1/2	59-3/8
2-3/8	61-7/16	61-3/4	62-5/8
2-1/2	64-11/16	65	66
2-5/8	67-7/8	68-1/4	69-1/4
4-1/8	106-3/4	107-1/4	108-13/16
4-1/4	110	110-1/2	112-1/8
4-3/8	113-3/16	113-3/4	115-3/8
4-1/2	116-7/16	117	118-11/16
4-5/8	119-11/16	120-1/4	122
2-3/4	71-1/8	71-1/2	72-9/16
2-7/8	74-3/8	74-3/4	75-7/8
3	77-5/8	78	79-3/16
3-1/8	80-13/16	81-1/4	82-1/2
3-1/4	84-1/16	84-1/2	85-3/4
3-3/8	87-5/16	87-3/4	89
3-1/2	90-9/16	91	92-5/16
3-5/8	93-13/16	94-1/4	95-5/8
3-3/4	97-1/16	97-1/2	98-7/8
3-7/8	100-1/4	100-3/4	102-3/16
4	103-1/2	104	105-1/2
4-1/8	106-3/4	107-1/4	108-13/16
4-1/4	110	110-1/2	112-1/8
4-3/8	113-3/16	113-3/4	115-3/8
4-1/2	116-7/16	117	118-11/16
4-5/8	119-11/16	120-1/4	122
4-3/4	122-15/16	123-1/2	125-5/16

Figure 581-5-4 Six-Link Dimensions for Flash-Butt-Welded Chain

581-5.4.7 FLASH-BUTT-WELDED CHAIN STUD INSPECTION. The studs in the FBW anchor chain shall be inspected for cracks. If crack(s) are found in the studs, then either paragraph 581-5.4.7.1 or paragraph 581-5.4.7.2 applies.

581-5.4.7.1 If a crack in the stud is running in the same direction as the circumferential weld between the stud and the link, then the crack has not affected the strength of the link and replacement is not required.

581-5.4.7.2 If a crack in the stud is running perpendicular or near perpendicular to the circumferential weld between the stud and the link and the crack has propagated into the body of the link, then the link has been weakened and replacement is required.

Table 581-5-4 PHYSICAL REQUIREMENTS, WEIGHT AND LINKS PER SHOT FOR FLASH-BUTT-WELDED CHAIN

Size of chain (inches)	Physical requirements		Weight		No. of links per shot
	Proof load (pounds)	Minimum break load (pounds)	Minimum per shot (pounds)	Maximum per shot (pounds)	
3/4	48,000	75,000	465	525	359
7/8	64,400	98,000	640	713	305
1	84,000	129,000	840	925	267
1-1/8	106,000	161,000	1050	1150	237
1-1/4	130,000	198,000	1310	1430	213
1-3/8	157,000	235,000	1590	1760	193
1-1/2	185,000	280,000	1890	2080	177
1-5/8	216,000	325,000	2180	2390	165
1-3/4	249,000	380,000	2520	2750	153
1-7/8	285,000	432,000	2900	3150	143
2	318,000	454,000	3270	3540	135
2-1/8	357,000	510,000	3690	3980	125
2-1/4	396,000	570,000	4150	4450	119
2-3/8	440,000	628,000	4640	4960	113
2-1/2	484,000	692,000	5150	5490	107
2-5/8	530,000	758,000	5670	6280	101
2-3/4	578,000	826,000	6240	6890	97
2-7/8	628,000	897,000	6840	7520	93
3	679,000	970,000	7460	8180	89
3-1/8	732,000	1,046,000	8090	8890	87
3-1/4	787,000	1,124,000	8760	9600	83
3-3/8	843,000	1,204,000	9470	10,350	79
3-1/2	900,000	1,285,000	10,220	11,140	77
3-5/8	958,000	1,369,000	10,990	12,190	73
3-3/4	1,019,000	1,455,000	11,660	12,920	71
3-7/8	1,080,000	1,543,000	12,540	13,850	69
4	1,143,000	1,632,000	13,330	14,680	67
4-1/8	1,207,000	1,724,000	14,080	15,520	65
4-1/4	1,272,000	1,817,000	14,830	16,360	63
4-3/8	1,338,000	1,911,000	15,570	17,200	61
4-1/2	1,405,000	2,008,000	16,300	18,030	59
4-5/8	1,474,000	2,105,000	17,010	18,840	57

Table 581-5-4 PHYSICAL REQUIREMENTS, WEIGHT AND LINKS PER SHOT FOR FLASH-BUTT-WELDED CHAIN - Continued

Size of chain (inches)	Physical requirements		Weight		No. of links per shot
	Proof load (pounds)	Minimum break load (pounds)	Minimum per shot (pounds)	Maximum per shot (pounds)	
4-3/4	1,700,000	2,550,000	18,370	20,300	57

Table 581-5-5 PHYSICAL REQUIREMENTS AND WEIGHT PER SHOT FOR NONMAGNETIC FLASH-BUTT-WELDED CHAIN

Size of chain (inches)	Physical requirements		Weight	
	Proof load (pounds)	Minimum break load (pounds)	Minimum per shot (pounds)	Maximum per shot (pounds)
3/4	39,600	64,800	520	563
7/8	53,900	88,200	705	765
1	70,400	115,200	920	1000
1-1/8	89,100	145,800	1165	1270
1-1/4	110,000	180,000	1435	1565

Table 581-5-6 DIMENSIONS FOR CONDEMNING ANCHOR CHAIN

Size of chain (inches)	90 Percent of link diameter [1] (inches)	Six-link dimension [2] (inches)
3/4	0.675	20-1/16
7/8	0.788	23-3/8
1	0.90	26-3/4
1-1/8	1.013	30-1/6
1-1/4	1.125	33-7/16
1-3/8	1.238	36-3/4
1-1/2	1.35	40-1/8
1-5/8	1.463	43-7/16
1-3/4	1.575	46-13/16
1-7/8	1.688	50-1/8
2	1.80	53-1/2
2-1/8	1.913	56-13/16
2-1/4	2.025	60-3/16
2-3/8	2.138	63-1/2
2-1/2	2.25	66-7/8
2-5/8	2.363	70-3/16
2-3/4	2.475	73-9/16
2-7/8	2.588	76-7/8
3	2.70	80-1/4
3-1/8	2.812	83-9/16
3-1/4	2.925	86-15/16
3-3/8	3.038	90-1/4
3-1/2	3.15	93-5/8
3-5/8	3.262	97

Table 581-5-6 DIMENSIONS FOR CONDEMNING ANCHOR CHAIN -

Continued

Size of chain (inches)	90 Percent of link diameter [1] (inches)	Six-link dimension [2] (inches)
3-3/4	3.375	100-5/16
3-7/8	3.488	103-5/8
4	3.60	107
4-1/8	3.7125	107-1/4
4-1/4	3.825	110-1/2
4-3/8	3.937	113-3/4
4-1/2	4.050	117
4-5/8	4.163	120-1/4
4-3/4	4.275	127-1/16

[1]Use micrometer, caliper or a GO/NO-GO gage to check wire diameter dimension. Gage is to be made by ship personnel/SIMA/repair facility in accordance with the dimensions of this table. Check the diameters at right angles to the link. When measuring with a micrometer or caliper take one-half the sum of the two diameters as representing the line diameter.NOTE: When using a GO/NO-GO gage, a failed check is to be verified by measuring with a micrometer or caliper. Measure the diameter at right angles and take one-half the sum of the two diameters as representing the link diameter. Take measurements on clean bare metal.

[2]Take six-link measurements with a load applied to the chain in order to take all slack out of the chain. Use a bar gauge to check the six-link dimension. When the gauge will not fit over six links, the chain has been stretched beyond allowable limit. Measure six links for the entire length of each shot, measuring from every third link. If the chain does not jump on the wildcat during raising and lowering under power, the six-link measurement is not required.

SECTION 6.

CHAIN APPENDAGES

581-6.1 GENERAL INFORMATION

581-6.1.1 CHAIN APPENDAGES AND TOOLS. Chain appendages and tools consist of:

Detachable links

Pear-shaped detachable links

End links

Bending shackles

Mooring shackles

Bitter end shackles

Swivels

Ball guides

Chain stoppers

Clear hawse pendant

Dip rope

Chain cable jacks

Chain stopper wrenches

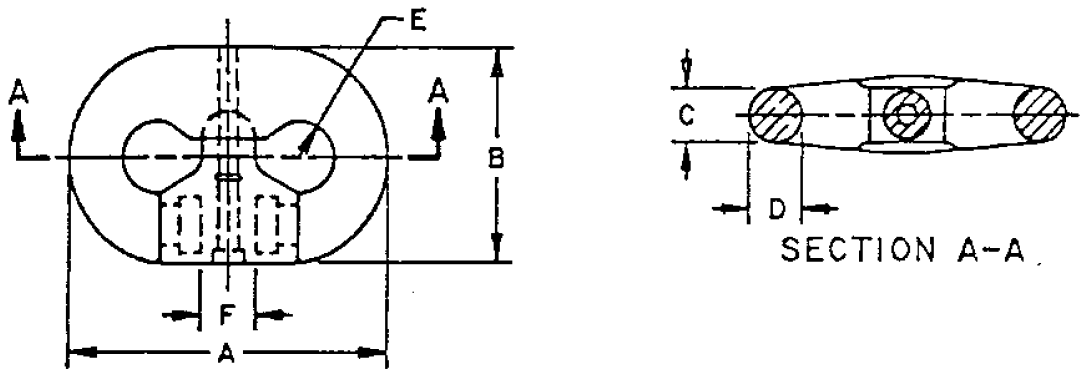
Detachable link tool sets.

581-6.1.2 RESTRICTION ON USE. Chain appendages on ships' anchor systems must be restricted to their intended purpose. Do not use similar but different size components for anchor chain appendages as they may fit physically, but their strength may be inadequate. All chain appendages, size for size, are of equal or greater strength than the chain. No welding of any type is allowed on any appendages.

581-6.2 APPENDAGE DESCRIPTIONS

581-6.2.1 DETACHABLE LINKS. The Navy-type detachable link has been adopted as a standard for use as a connecting link for joining shots of anchor chain on Navy ships. The detachable link is also used in the outboard swivel shot to connect the swivel with other common chain links, for connection to the end link, and in the chain stoppers to connect the turnbuckle to the shackle at one end and pelican hook assembly at the other. The strength of the detachable link in the chain stopper does not match the anchor chain size or strength when two or three chain stoppers are required to hold the ship at anchor. When one chain stopper is specified, the stopper detachable links are of greater strength than the chain.

581-6.2.1.1 Standard. Standard detachable links are manufactured to the requirements of MIL-L-2710, Type I, Class 1 and NAVSHIPS dwg 803-860062. Dimensions and physical requirements for standard detachable links are given in Figure 581-6-1. Standard detachable links are made in sizes to match the chain sizes, from 1-7/8 to 4-3/4 inches. Standard detachable links from 3/4- to 1-3/4 inches are no longer available to Navy ships. These sizes are supplied only in the high-strength type. If it is required to replace a 3/4- to 1-3/4 inch standard detachable link, use the high-strength detachable link as a replacement.



Size of [1] chain (inches)	Dimension (inches)						Physical requirements	
	A	B	C	D	E	F	Proof load (pounds)	Break load (pounds)
1-7/8	11-1/4	7-1/4	1-7/8	1-7/8	1-15/64	2-3/16	285,000	432,000
2	12	7-3/4	2	2	1-5/16	2-5/16	322,000	488,000
2-1/8	12-3/4	8-1/4	2-1/8	2-1/8	1-13/32	2-1/2	362,000	548,000
2-1/4	13-1/2	8-23/32	2-1/4	2-1/4	1-1/2	2-5/8	403,000	610,000
2-3/8	14-1/4	9-7/32	2-3/8	2-3/8	1-9/16	2-3/4	447,000	675,000
2-1/2	15	9-11/16	2-1/2	2-1/2	1-21/32	2-7/8	492,000	744,000
2-5/8	15-3/4	10-3/16	2-5/8	2-5/8	1-3/4	3-1/16	540,000	813,000
2-3/4 STD [2]	16-1/2	10-5/8	2-3/4	2-3/4	1-13/16	3-3/16	530,000	886,000
2-3/4 HD	16-1/2	10-13/16	2-7/8	2-3/4	1-13/16	3-1/4	649,000	981,000
2-7/8	17-1/4	11-1/8	2-7/8	2-7/8	1-29/32	3-11/32	640,000	965,000
3 STD [2]	18	11-5/8	3	3	1-31/32	3-17/32	693,000	1,045,000
3 HD	18	11-7/8	3-3/16	3	1-29/32	3-3/8	762,000	1,150,000
3-1/8	18-3/4	12-1/8	3-1/8	3-1/8	2-3/64	3-5/8	748,000	1,128,000
3-1/4	19-1/2	12-5/8	3-1/4	3-1/4	2-5/32	3-5/8	805,000	1,250,000
3-3/8	20-1/4	13-3/32	3-3/8	3-3/8	2-1/4	3-15/16	862,000	1,304,000
3-1/2 STD[2]	21	13-9/16	3-1/2	3-1/2	2-19/64	4-1/16	922,000	1,383,100
3-1/2 HD	21-1/8	13-25/32	3-3/4	3-1/2	2-13/32	4-1/8	1,080,000	1,700,000
3-3/4	22-1/2	14-1/2	3-3/4	3-3/4	2-7/16	4-11/32	1,045,000	1,575,000
4–3/4	28-1/2	18-7/16	4-3/4	4-3/4	3-1/8	5-1/2	1,700,000	2,550,000

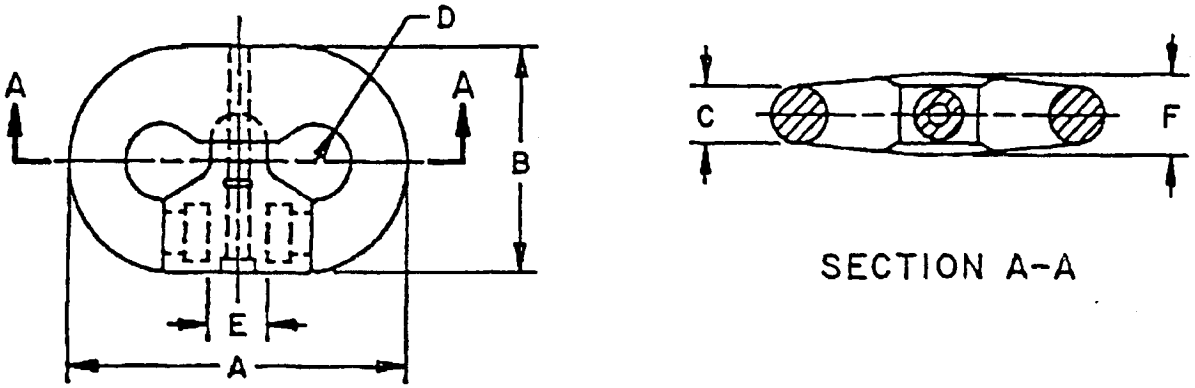
[1] STD is standard and HD is heavy-duty.

[2] No longer manufactured – use HD in all three cases.

Figure 581-6-1 Dimensions and Physical Requirement for Standard and Heavy-Duty Detachable Links

581-6.2.1.2 Heavy-Duty. Heavy-duty detachable links are manufactured to the requirements of MIL-L-2710, Type I, Class 2 and NAVSHIPS dwg 803-860062. Heavy-duty detachable links are made in three sizes: 2-3/4, 3- and 3-1/2 inches. Dimensions and physical requirements for heavy-duty detachable links are given in Figure 581-6-1. Standard detachable links in these sizes are no longer manufactured.

581-6.2.1.3 High-Strength. High-strength detachable links are manufactured to the requirements of MIL-L-2710, Type I, Class 3 and NAVSHIPS dwg 803-921790. High-strength detachable links are made in nine sizes, from 3/4- to 1-3/4 inches, in 1/8-inch increments. They replace the standard detachable links in these sizes. Dimensions and physical requirements for high-strength detachable links are given in Figure 581-6-2. Standard detachable links in these sizes are no longer manufactured.



Size of chain (inches)	Dimension (inches)						Physical requirements	
	A	B	C	D	E	F	Proof load (pounds)	Break load (pounds)
3/4	4-1/2	3	3/4	1/2	27/32	1-3/64	67,500	91,000
7/8	5-1/4	3-1/2	7/8	19/32	63/64	1-7/32	88,200	119,000
1	6	4	1	21/32	1-1/8	1-25/64	116,100	156,700
1-1/8	6-3/4	4-1/2	1-1/8	47/64	1-17/64	1-9/16	145,000	195,000
1-1/4	7-1/2	5	1-1/4	13/16	1-13/32	1-47/64	178,200	240,600
1-3/8	8-1/4	5-1/2	1-3/8	29/32	1-35/64	1-29/32	211,500	285,500
1-1/2	9	6	1-1/2	63/64	1-11/16	2-5/64	252,000	340,200
1-5/8	9-3/4	6-1/2	1-5/8	1-1/16	1-53/64	2-1/4	292,500	395,000
1-3/4	10-1/2	7	1-3/4	1-3/16	1-31/32	2-7/16	352,000	476,000

Figure 581-6-2 Dimensions and Physical Requirement for High-Strength Detachable Links

581-6.2.1.4 Assembly. The Navy-type detachable link consists of a forged steel C-shaped link and two forged steel coupling plates. The coupling plates close the open sides of the C-shaped link. The coupling plates are heated at assembly and pressed together to take the shape of the C-shaped link ends which are commonly called buttons. The coupling plates are held together with a driven tapered pin. A lead plug is hammered into the cou-

pling plates to prevent the tapered pin from backing out (see Figure 581-6-3). On outboard swivel shots, the coupling plates and tapered pin are machined so that a hairpin can be installed to prevent the tapered pin from backing out (see Figure 581-6-4).

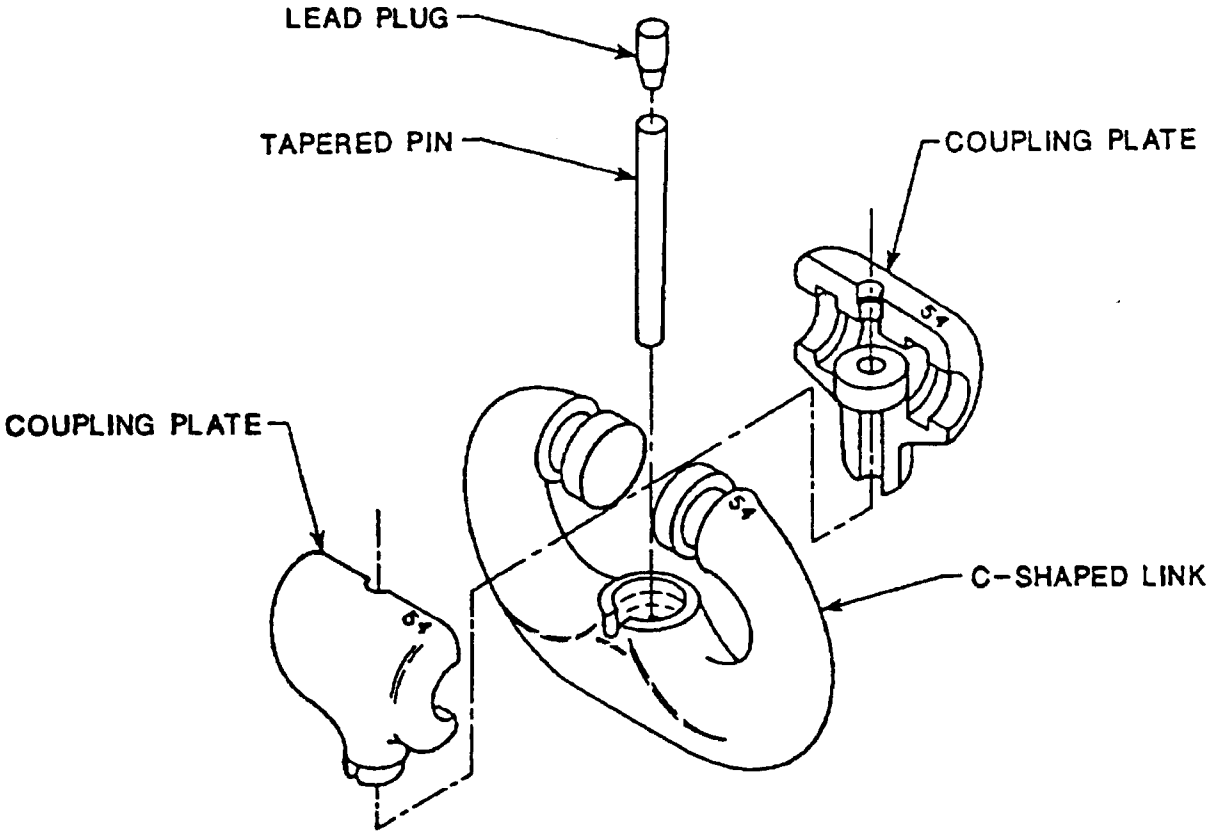


Figure 581-6-3 Detachable Link (Exploded view)

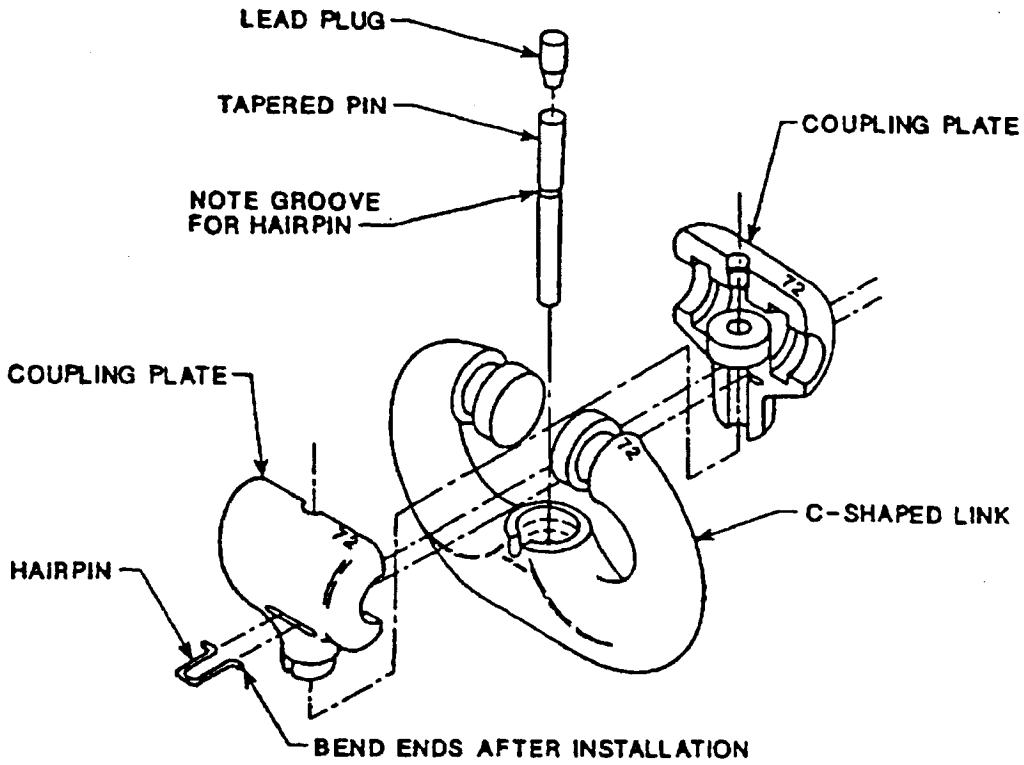


Figure 581-6-4 Detachable Link with Hairpin

581-6.2.1.5 Orientation. It is required that the detachable links be orientated on the wildcat as described in paragraph 581-5.1.4.1. The detachable links are approximately the same size and shape as the common links. However, because of small differences in shape, they must be installed in the chain so that they ride over the wildcat in the grooves. As it is required that there be an odd number of common links within each shot, all detachable links will have the same orientation on the wildcat from shot to shot (see paragraph 581-5.4.3).

581-6.2.1.6 Match Marks. The C-shaped link and coupling plates are provided with random match marks by the manufacturer. The match marks typically are numbers, stamped on the parts after assembly. When a detachable link is taken apart, the match marks help to identify the coupling plates that were originally assembled with the C-shaped link. There is a projection on one of the coupling plates that fits in a notch in the C-shaped link to maintain the original fit. The match marks and notch are illustrated in Figure 581-6-5.

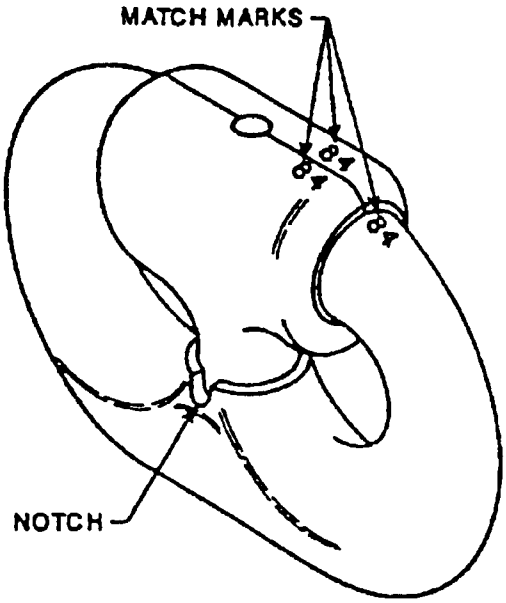
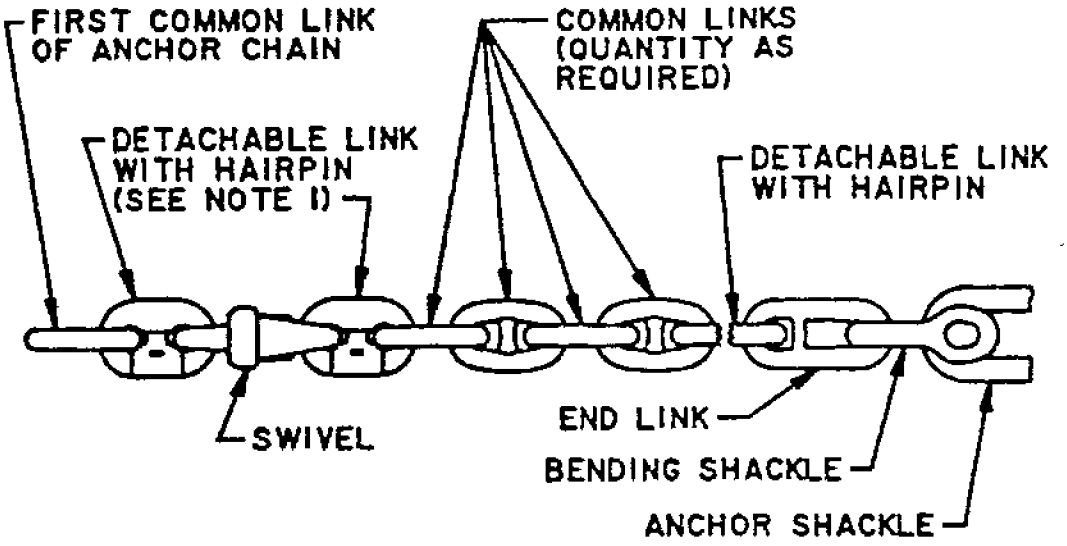


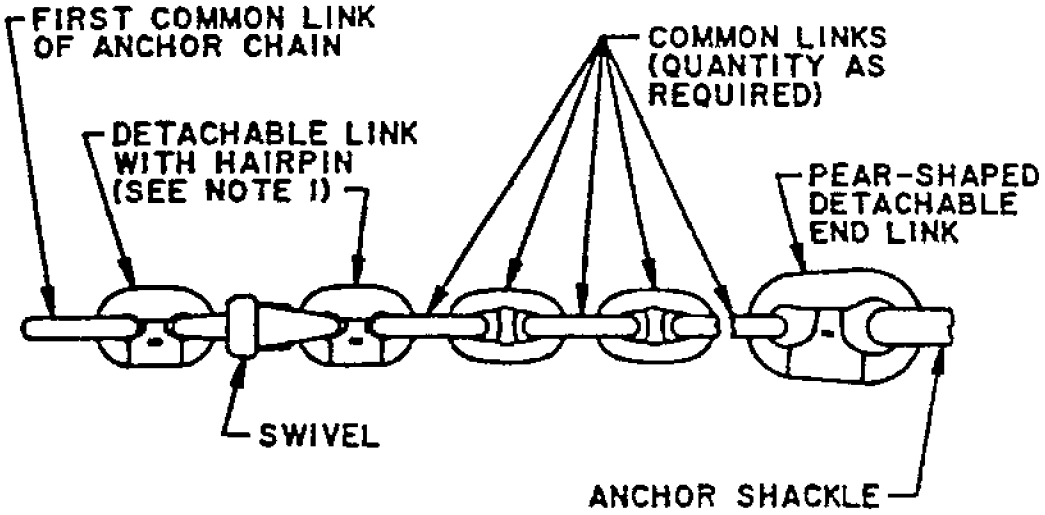
Figure 581-6-5 Detachable Link (Assembled)

581-6.2.1.7 Hairpin. The hairpin is a required safety feature installed in detachable links that are installed in the outboard swivel shot. Detachable links used to join shots of chain may be equipped with hairpins but it is not mandatory. The hairpin is made from corrosion-resistant steel (FED Spec QQ-S-763, Class 304, Condition A). It is a clip that is pushed through holes in the coupling plates. There is a matching groove in the tapered pin. The hairpin fits into the grooves and prevents the tapered pin from falling out. The ends of the hairpin are bent over after installation to prevent the hairpin from falling out (see Figure 581-6-4). The hairpin was added after the Navy experienced the loss of coupling plates on the outboard swivel shot detachable links when anchored. Before disassembly of the detachable link, find replacement material for the hairpin as it is usually destroyed when taking the detachable link apart. The hairpin may be fabricated onboard ship as they are not stocked in the supply system.

581-6.2.2 PEAR-SHAPED DETACHABLE LINKS. Pear-shaped detachable links are similar to standard detachable links except that one end is enlarged in both size and opening (see NAVSEA dwg 803-6397316). The pear-shaped detachable link is commonly referred to as a detachable end link. The pear-shaped detachable link may be used to connect the first link of the outboard swivel shot to the anchor shackle (see Figure 581-6-6) and is to be equipped with a hairpin similar to that shown in Figure 581-6-4. Since the Boston Navy Shipyard shut down its forge shop, pear-shaped detachable links have been purchased from commercial sources to match the strength and size of the anchor chain. New pear-shaped detachable links will be furnished to the dimensions in Figure 581-6-7. All pear-shaped detachable links are proof load tested to the physical requirements of Table 581-6-1 and samples are tested to the minimum break load. The manufacturer performs these tests.



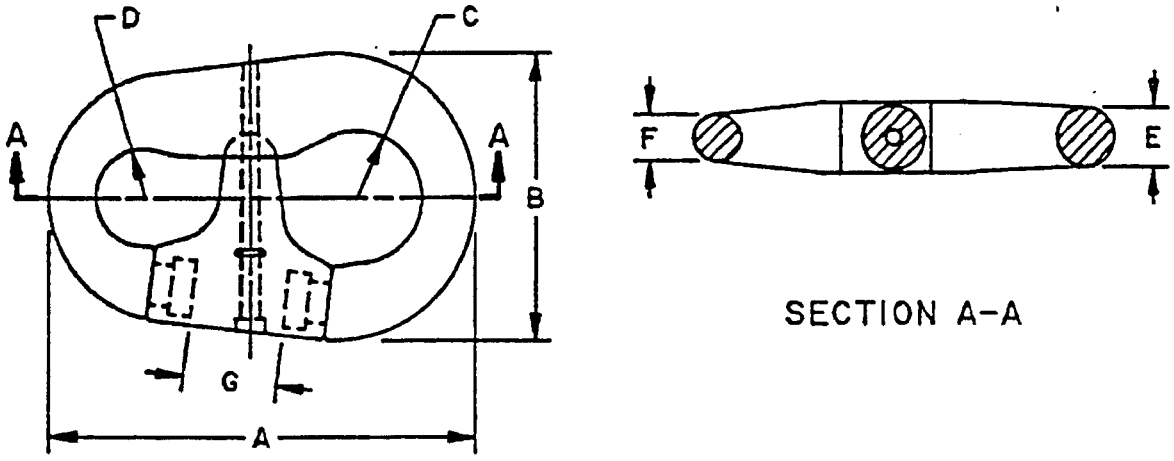
STANDARD OUTBOARD SWIVEL SHOT



ALTERNATE OUTBOARD SWIVEL SHOT

NOTE:
1. ON SOME SHIPS IN SERVICE, COMMON LINKS ARE USED IN THESE LOCATIONS IN LIEU OF D-LINKS.

Figure 581-6-6 Outboard Swivel Shot

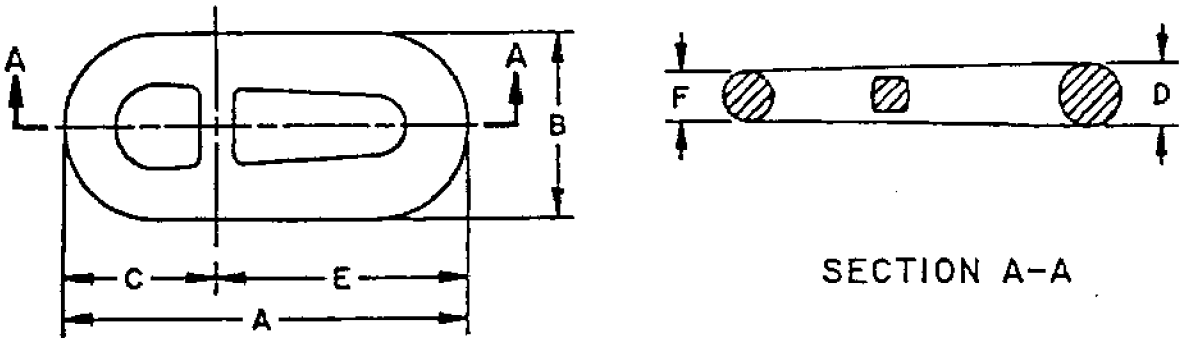


Link[1] no.	Dimension (inches)						
	A	B	C	D	E	F	G
2	7-5/8	5-1/4	1-3/16	21/32	1-1/4	15/16	2-1/4
3	9-3/8	6-9/16	1-3/8	3/4	1-1/2	1-3/16	2-19/32
4	11-3/4	8-1/8	1-11/16	1-1/32	1-7/8	1-9/16	3-1/4
5	14-7/8	10-1/4	2-1/16	1-1/4	2-1/2	2	3-15/16
6	17-7/8	12-5/16	2-17/32	1-15/32	3	2-3/8	4-3/4
7	22-1/8	14-13/16	3	1-29/32	3-3/4	3-1/8	5-7/8
8	25-3/4	16-1/2	3-1/8	2-1/8	4-7/8	3-5/8	5-7/8

[1]See table 6–1 for size of chain that matches the link number.

Figure 581-6-7 Dimensions for Pear-Shaped Detachable Links

581-6.2.3 END LINKS. Ends links are similar to the chain common links except that one end is longer and of larger diameter. The shorter end of the end link is joined to the adjacent common link in the outboard swivel shot by a detachable link. The opening in the end link's longer end will accept the bending shackle. Today, end links are produced as one-piece forgings (see paragraph 581-6.3.3). Do not use an end link in any portion of the anchor chain that passes over the wildcat. The use of the end link is illustrated in Figure 581-6-6 and dimensions and physical characteristics are given in Figure 581-6-8 and on NAVSEA dwg 803-6397315.



Size of [1] chain (inches)	Dimension (inches)						Physical requirements	
	A	B	C	D	E	F	Proof load (pounds)	Break load (pounds)
3/4	6-1/4	3-1/4	2-1/4	1	4	13/16	48,000	75,000
7/8	7-1/4	3-5/8	2-9/16	1-1/8	4-11/16	15/16	64,400	98,000
1	8-3/16	4	2-7/8	1-1/4	5-5/16	1-1/16	84,000	129,000
1-1/8	9	4-1/2	3-3/8	1-3/8	5-5/8	1-3/16	106,000	161,000
1-1/4	9-7/8	4-3/4	3-9/16	1-1/2	6-5/16	1-5/16	130,000	198,000
1-3/8	11-1/2	6	4-1/4	1-3/4	7-1/4	1-1/2	157,000	235,000
1-1/2	12	6	4-3/8	1-7/8	7-5/8	1-5/8	185,000	280,000
1-5/8	13-3/16	6-3/8	4-5/8	2	8-9/16	1-3/4	216,000	325,000
1-3/4	14	6-7/8	5	2-1/8	9	1-7/8	249,000	380,000
1-7/8	15-5/8	7-3/8	5-1/2	2-1/4	10-1/8	2	285,000	432,000
2 - 2-1/8	17	8-1/8	6	2-1/2	11	2-1/8	357,000	510,000
2-1/4 - 2-3/8	18-5/8	9-1/4	6-3/8	2-3/4	12-1/4	2-3/8	440,000	628,000
2-1/2 - 2-5/8	21	10	7-1/4	3	13-3/4	2-5/8	530,000	758,000
2-3/4 HD - 2-3/4 - 2-7/8	22-3/8	10-7/8	7-3/4	3-1/4	14-5/8	2-7/8	628,000	897,000
3-3 HD - 3-1/8	24	11-3/4	8-3/8	3-1/2	15-5/8	3-1/8	732,000	1,046,000
3-1/4 - 3-3/8	28-1/2	13-1/2	9-1/2	4	19	3-1/2	843,000	1,204,000
3-1/2 – 3-1/2 HD - 3-3/4	31-1/8	15	10-13/16	4-1/2	20-5/16	4	1,019,000	1,575,000
3-7/8 - 4	33-3/4	16-1/2	12	5	21-3/4	4-1/2	1,143,000	1,632,000
4-3/4	37-1/4	18-1/2	12-3/4	5-3/4	24-1/2	4-7/8	1,700,000	2,550,000

[1]HD is heavy-duty.

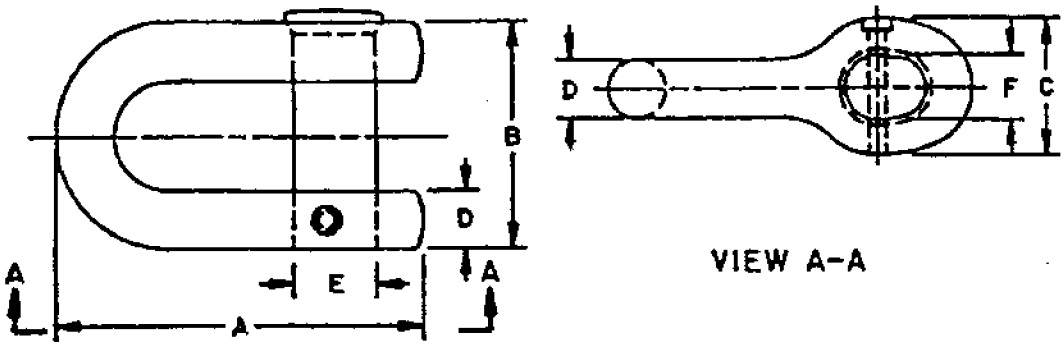
Figure 581-6-8 Dimensions and Physical Requirements for End Links

Table 581-6-1 PHYSICAL REQUIREMENTS FOR PEAR-SHAPED DETACHABLE LINKS

Link no.	Size of [1] chain (inches)	Physical Requirements	
		Proof load (pounds)	Break load (pounds)
2	3/4 HS - 7/8 HS	88,200	119,000
3	1 HS - 1-1/8 HS	145,000	195,000
4	1-1/4 HS - 1-1/2 HS	252,000	340,000
5	1-5/8 HS - 1-3/4 HS - 2	352,000	476,000
6	2-1/8 - 2-3/8	447,000	675,000
7	2-1/2 - 3-1/8 - 2-3/4 HD - 3 HD	762,000	1,150,000
8	3-1/4 - 3-1/2 - 3-1/2 HD	1,080,000	1,700,000

[1]HS is high-strength and HD is heavy-duty.

581-6.2.4 BENDING SHACKLES. Bending shackles are used to connect the end link on the outboard swivel shot to the anchor shackle. Bending shackles are manufactured in accordance with NAVSEA dwg 803-6397320. The clevis pin in the bending shackle is oval-shaped and held in place with two locking pins for shackles 1-5/8 inch and larger. One locking pin for 3/4 inch to 1-1/2 inch shackles is required. The use of the bending shackle is illustrated in Figure 581-6-6 and dimensions and physical requirements are given in Figure 581-6-9.



Size of [1] chain (inches)	Dimension (inches)						Physical requirements	
	A	B	C	D	E	F	Proof load (pounds)	Break load (pounds)
3/4	6-1/4	4	2-3/8	1	1-25/64	1-9/64	48,000	75,000
7/8	7-1/4	4-1/2	2-5/8	1-1/8	1-37/64	1-17/64	64,400	98,000
1	7-7/8	4-7/8	3	1-1/4	1-49/64	1-25/64	84,000	129,000
1-1/8	8-5/8	5-3/8	3-3/8	1-3/8	1-61/64	1-33/64	106,000	161,000
1-1/4	9-3/8	5-7/8	3-5/8	1-1/2	2-9/64	1-49/64	130,000	198,000
1-3/8	10-3/4	6-1/2	4-1/4	1-3/4	2-17/32	2-1/32	157,000	235,000
1-1/2	11-1/2	6-7/8	4-5/8	1-7/8	2-25/32	2-9/32	185,000	280,000
1-5/8	12-1/4	7-3/8	5	2	2-31/32	2-13/32	216,000	325,000
1-3/4	13-1/8	8-1/8	5-1/4	2-1/4	3-5/32	2-17/32	249,000	380,000
1-7/8	14-5/8	8-3/4	6	2-1/2	3-35/64	2-59/64	285,000	432,000
2 - 2-1/8	15-7/8	9-1/2	6-5/8	2-3/4	3-59/64	3-11/64	357,000	510,000
2-1/4 - 2-3/8	17-3/8	10-3/8	7-1/4	3	4-19/64	3-27/64	440,000	625,000
2-1/2 - 2-5/8	19-1/8	11-1/8	8	3-1/4	4-11/16	3-13/16	530,000	758,000
2-3/4 HD - 2-3/4 - 2-7/8	20-1/2	12-3/8	8-5/8	3-5/8	5-1/16	4-1/16	628,000	897,000
3 HD - 3- 3-1/8	22-5/8	13-1/4	9-5/8	4	5-11/16	4-9/16	732,000	1,046,000
3-1/4	24	13-7/8	10-1/4	4-1/4	6-1/16	4-15/16	787,000	1,124,000
3-3/8	24	14-1/4	10-1/4	4-1/4	6-1/16	4-15/16	843,000	1,204,000
3-1/2	25-1/2	14-3/4	10-7/8	4-1/2	6-7/16	5-3/16	900,000	1,285,000
3-1/2 HD - 3-5/8 - 3-3/4	27-5/8	16	11-3/4	4-7/8	7	5-13/16	1,019,000	1,575,000
4-3/4	34-3/4	20-3/4	14-1/2	6	8-9/16	6-13/16	1,700,000	2,550,000

[1]HD is heavy-duty.

Figure 581-6-9 Dimensions and Physical Requirements for Bending Shackles

581-6.2.5 MOORING SHACKLES. Mooring shackles are used for attaching the anchor chain to mooring buoys. The opening between the jaws of the shackle is seven inches wide for all shackle sizes. The mooring shackles are manufactured to the requirements of NAVSHIPS dwg 803-921734. The mooring shackle is illustrated in Figure 581-6-10.

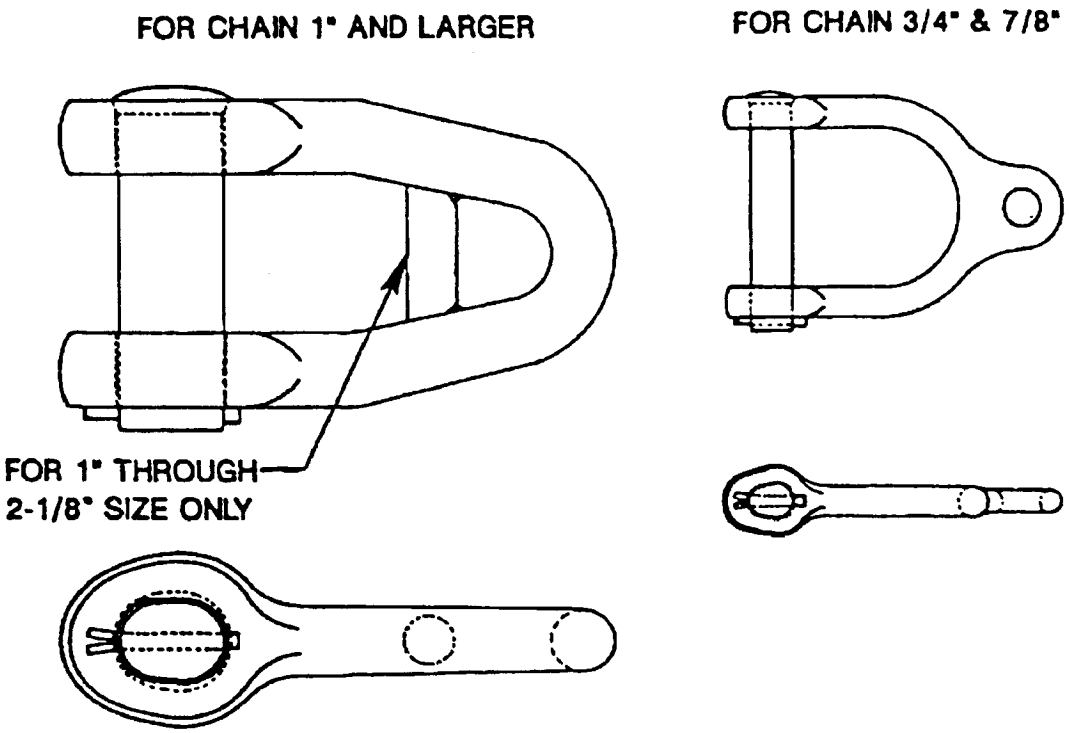


Figure 581-6-10 Mooring Shackles

581-6.2.5.1 Mooring shackles for chain sizes 1-inch up to and including 2-1/8 inches, have a bar installed to support the sides of the shackle. Mooring shackles for chain sizes 2-1/4 inches and larger do not have a bar installed between the sides of the shackle.

581-6.2.6 BITTER END SHACKLES (SURFACE SHIP). The bitter end shackle (see Figure 581-6-11) is used to attach the anchor chain to the chain locker padeye. The padeye in the chain locker is designed so that it is 1.75 times the strength of the bitter end shackle with a factor of safety of three on the ultimate strength of the material. The minimum breaking strength of the bitter end shackle should be approximately equal to the weight of 20 shots of chain. Bitter end shackles are safety anchor shackles, manufactured per requirements of FED Spec RR-C-271, Type IV-A, Class 3, Grade A. Recommended bitter end shackle sizes are given in Table 581-6-2.

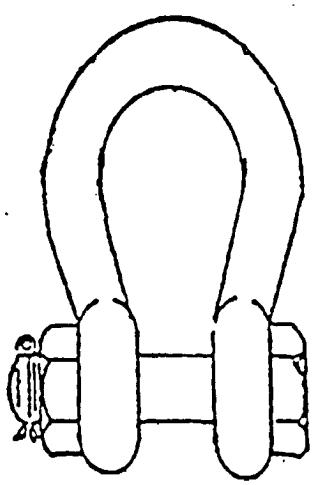
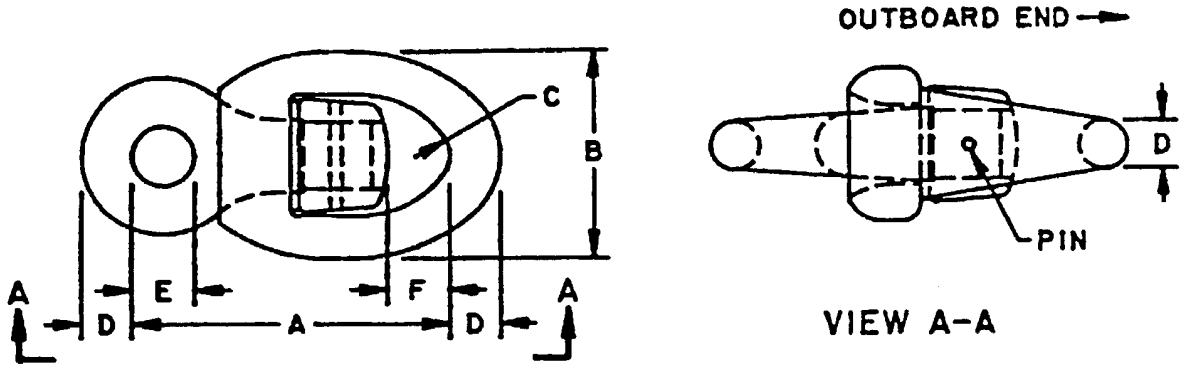


Figure 581-6-11 Bitter End Shackle (Surface Ship)

581-6.2.7 SWIVELS. Swivels are installed in the outboard swivel shot and serve to eliminate twisting of the chain. The swivel allows continuous rotation in both directions. There is a phosphorous bronze washer between the nut and the swivel box which functions as a thrust bearing. The swivel allows the anchor to turn as it is housed in the hawse pipe, otherwise the twist in the chain could cause the chain to slip or jump the wildcat. The swivels are manufactured to the requirements of NAVSEA dwg 803-5959226 for the 3/4- to 4-inch chain size and 803-6397253 for the 4-3/4 chain size. A pin is used to prevent the nut from loosening on the eye bolt shank and the ends of the pin are plug-welded in the nut at assembly. The pin is installed in a hole drilled through the nut and eyebolt shank. The use of the chain swivel is illustrated in Figure 581-6-6 and its dimensions and physical characteristics are given in Figure 581-6-12.

Size of[1] chain (inches)	Maximum chain weight (pounds)		Bitter end shackle	
	1 Shot 15 fathoms (90 ft)	20 Shots = 300 fathoms (1800 ft)	Minimum breaking strength (pounds)	Size (in.)
3–3/4	12,920	258,400	270,000	2–1/4
3–7/8	13,850	277,000	270,000	2–1/4
4	14,680	293,600	338,000	2–1/2
4–3/4	20,300	406,000	481,000	3

(1) HS refers to high-strength, die-lock chain and HD refers to heavy-duty, die-lock chain and their maximum weights. All other data reflects maximum weight of flash-butt-welded chain.



Swivel size	Swivel overall dimensions						Physical requirements	
	A	B	C	D	E	F	Proof load (pounds)	Break load (pounds)
3/4	4-25/32	3-1/8	1/2	3/4	31/32	31/32	67,500	91,100
7/8	6-3/8	4-1/4	3/4	7/8	1-1/8	1-7/16	88,200	119,000
1	6-11/16	4-1/4	5/8	1	1-5/16	1-5/16	116,100	156,700
1-1/8 - 1-1/4	7-15/16	5-1/4	3/4	1-1/4	1-5/8	1-5/8	178,200	240,600
1-3/8 - 1-1/2	11-1/4	7-3/8	1-1/2	1-1/2	2-1/8	2	252,000	340,200
1-5/8 - 1-3/4	11-3/8	7-3/8	1-1/4	1-3/4	2-1/4	2-1/4	352,000	476,000
1-7/8 - 2	13	8-3/8	1-1/4	2	2-5/8	2-5/8	318,000	454,000
2-1/8	14-1/16	9	1-3/8	2-1/8	2-3/4	2-3/4	357,000	510,000
2-1/4 - 2-3/8	15-1/2	10	1-5/8	2-3/8	3-1/8	3-1/8	440,000	628,000
2-1/2 - 2-5/8	18-1/4	12	2	2-5/8	3-1/2	3-11/16	530,000	758,000
2-3/4 - 2-3/4 HD - 2-7/8	19-1/8	12	2	2-7/8	3-7/8	3-7/8	628,000	897,000
3 - 3 HD - 3-1/8 - 3-1/4	22-1/2	14-1/4	1-1/4	3-1/4	4-1/4	4-3/8	787,000	1,124,000
3-3/8 - 3-1/2	24-5/16	16-1/4	2-1/2	3-1/2	4-5/8	5	900,000	1,285,000
3-1/2 HD - 3-5/8 - 3-3/4	27-1/4	18	2-3/4	3-7/8	5-1/4	5-1/2	1,019,000	1,575,000
3-7/8 - 4	These sizes have not been developed							
4-3/4	30-3/4	20	3-1/4	4-3/4	6-1/4	6-3/4	1,700,000	2,550,000

Note: HD refers to heavy-duty, die-lock chain. Use the 3-1/2 HD, 3-5/8 or 3-3/4 size swivel for 3-1/2 flash-butt-welded stud link anchor chain.

Figure 581-6-12 Dimensions and Physical Requirements for Chain Swivels

581-6.2.7.1 Swivel Orientation. The outboard end of the swivel is marked in view A-A of Figure 581-6-12. The swivel shall be installed in this orientation in all outboard swivel shots. This will preclude the possibility that the leading edge of the swivel basket could catch on the edge of the hawse pipe deck bolster as the anchor falls.

Table 581-6-2 RECOMMENDED BITTER END SHACKLE SIZE

	Maximum chain weight (pounds)		Bitter end shackle	
Size of [1] chain (inches)	1 Shot 15 fathoms (90 ft)	20 Shots = 300 fathoms (1800 ft)	Minimum breaking strength (pounds)	Size (in.)
3/4	525	10,000	10,850	7/16
3/4 HS	550	11,000	10,850	7/16
7/8	713	14,260	14,150	1/2
1	925	18,500	22,100	5/8
1 HS	1000	20,000	22,100	5/8
1-1/8	1150	23,000	22,100	5/8
1-1/8 HS	1270	25,400	31,800	3/4
1-1/4	1430	28,600	31,800	3/4
1-3/8	1760	35,200	43,250	7/8
1-3/8 HS	1900	38,000	43,250	7/8
1-1/2	2080	41,600	43,250	7/8
1-1/2 HS	2260	45,200	56,550	1
1-5/8	2390	47,800	56,550	1
1-5/8 HS	2620	52,400	56,550	1
1-3/4	2750	55,000	56,550	1
1-7/8	3150	63,000	66,800	1-1/8
2	3540	70,800	82,500	1-1/4
2-1/8	3980	79,600	82,500	1-1/4
2-1/4	4450	89,000	99,800	1-3/8
2-3/8	4960	99,200	99,800	1-3/8
2-1/2	5490	109,800	118,700	1-1/2
2-5/8	6280	125,600	139,500	1-5/8
2-3/4	6890	137,800	139,500	1-5/8
2-3/4 HD	7000	140,000	139,500	1-5/8
2-7/8	7520	150,400	161,600	1-3/4
3	8180	163,600	161,600	1-3/4
3 HD	8100	162,000	161,600	1-3/4
3-1/8	8890	177,800	211,000	2
3-1/4	9600	192,000	211,100	2
3-3/8	10,350	207,000	211,100	2
3-1/2	11,140	222,800	211,100	2
3-1/2 HD	12,000	240,000	270,000	2-1/4
3-5/8	12,190	243,800	270,000	2-1/4
3-3/4	12,920	258,400	270,000	2-1/4
3-7/8	13,850	277,000	270,000	2-1/4
4	14,680	293,600	338,000	2-1/2
4-3/4	20,300	406,000	481,000	3

[1]HS refers to high-strength, die-lock chain and HD refers to heavy-duty, die-lock chain and their maximum weights. All other data reflects maximum weight of flash-butt-welded chain.

581-6.2.8 OUTBOARD SWIVEL SHOTS. Outboard swivel shots consist of the appendages and chain as shown in Figure 581-6-6. The end link is attached to the common link by a detachable link. The outboard swivel shot is commonly called a bending shot and attaches the first shot of anchor chain to the anchor. Outboard swivel shots are illustrated in Figure 581-6-6. The outboard swivel shot is also detailed on NAVSEA dwg 803-5959227. Diameters of common links in the outboard swivel shot are subject to the same tolerance limitations as required in Table 581-5-6, note (1).

581-6.2.8.1 Link Size. The size of the common links in the outboard swivel shot shall be the same size as the common links used in the anchor chain.

581-6.2.8.2 Configuration. The configuration of the outboard swivel shot is partially determined by the requirement that the chain swivel is inboard of the outboard chain stopper when the anchor is housed in the hawse pipe. This will allow for disconnecting the detachable links for replacement or maintenance or for maintenance of the chain swivel without dropping the anchor. The number of common links is adjusted to provide the required length. All of the appendages must be the same size and are equal to or of greater strength than the common links in the anchor chain.

581-6.2.8.3 Alternate Outboard Swivel Shot. The alternate outboard swivel shot is used with the 3/4- to 1-3/4 inch high-strength die-lock chain. The end link, bending shackle and detachable link required in a standard outboard swivel shot are replaced with a pear-shaped detachable link. All of the appendages must be the same size and are equal to or of greater strength than the common links in the anchor chain. Common links in the alternate outboard swivel shot are subject to the same tolerance limitations as required in Table 581-5-6, note (1).

581-6.2.8.4 Hairpins. Install hairpins in all standard and pear-shaped detachable links in the outboard swivel shot. The hairpin is an additional safety measure to prevent the tapered pin from falling out of the detachable link coupling plates.

581-6.2.9 CHAIN STOPPERS. The Navy standard chain stoppers are used for securing the anchor in the hawse pipe, for riding to an anchor, for holding the anchor when the chain is disconnected for any reason or for securing the anchor chain when the chain is used for towing purposes Chain stoppers used for towing shall be equipped with two locking plates, modified eyebolts and cotter pins, in accordance with NAVSHIPS dwg 804-860000, PCS 17, 18, 19 and 20. If more than one chain stopper is used on a chain, the load should be as equally distributed as possible when adjusting the chain stopper turnbuckle. The Navy standard chain stopper consists of a shackle, detachable links, a turnbuckle assembly and a pelican hook assembly. The pelican hook assembly's main components are a strongback, pelican hook, bail and pivot pins. Chain stoppers are manufactured to the requirements of NAVSHIPS dwg 804-860000. Figure 581-6-13 illustrates a typical chain stopper.

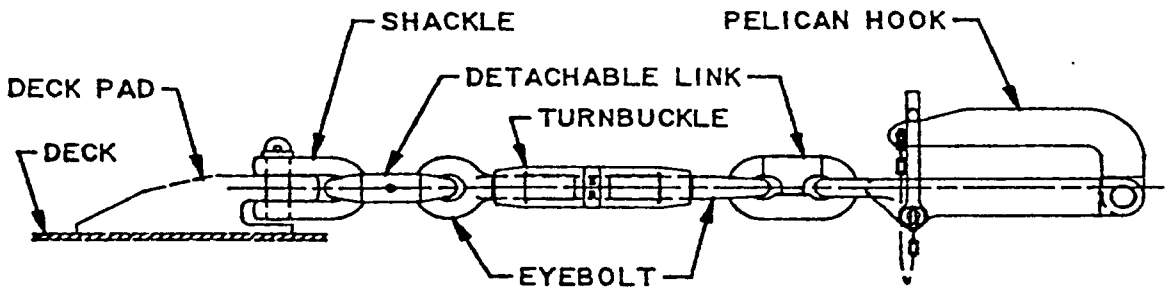


Figure 581-6-13 Chain Stopper

581-6.2.9.1 Design Strength. On Navy ships with one chain stopper required per chain, the chain stopper strength is equal to or greater than the breaking strength of the chain. On Navy ships with two or three chain stoppers, the combined strength of all chain stoppers is equal to or greater than 120 percent of the breaking strength of the chain.

581-6.2.9.2 Location. When determining locations for attaching chain stoppers to the deck, the deck pads should be positioned so that the stoppers will be standard length and lead as nearly as practicable in line with the chain. Consideration must also be given to the relative location of chain swivels. Locate the outboard chain stopper so that the swivel is inboard when the anchor is in the housed position. Also, the chain stoppers should never close on or bear against a detachable link or the swivel. This facilitates removal of the swivel or detachable links for periodic inspections.

581-6.2.9.3 Devil's Claw or Pawl-Type. Some Navy ships are equipped with devil's claw or pawl-type chain stoppers. The devil's claw has a split hook that engages the end of a horizontal chain link. A turnbuckle assembly is used to tension the devil's claw. The disadvantage of the devil's claw chain stopper is that it has no quick release feature. It is released by loosening the turnbuckle assembly when the weight of the anchor and chain is taken by the wildcat. The pawl-type chain stopper has a base attached to the deck and a pivoted pawl that rides on top of the chain as the anchor is handled in. The pawl prevents the chain from running out by falling into the space between the vertical links. The disadvantage of the pawl-type chain stopper is that windlass power is required to haul the anchor chain in a short distance so the pawl can be raised or if power is lost, a chain stopper (Figure 581-6-13) tightened to allow disengagement of the pawl.

581-6.2.10 CLEAR HAWSE PENDANTS. The clear hawse pendant is used in buoy mooring or clearing a hawse which has been fouled by anchor chain. Clear hawse pendants are manufactured per the requirements and dimensions shown on NAVSHIPS dwg 803-668185. The five to 15 fathom (30 to 90 ft) length of wire rope is fitted with an open thimble at one end and a solid thimble at the other end. The solid thimble end is attached to a length of open link chain and a pelican hook. The clear hawse pendant is illustrated in Figure 581-6-14.

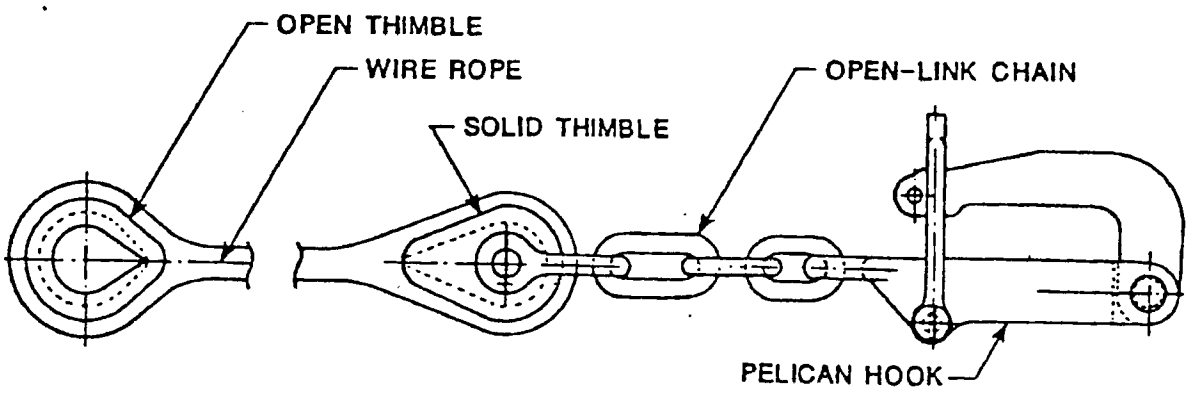
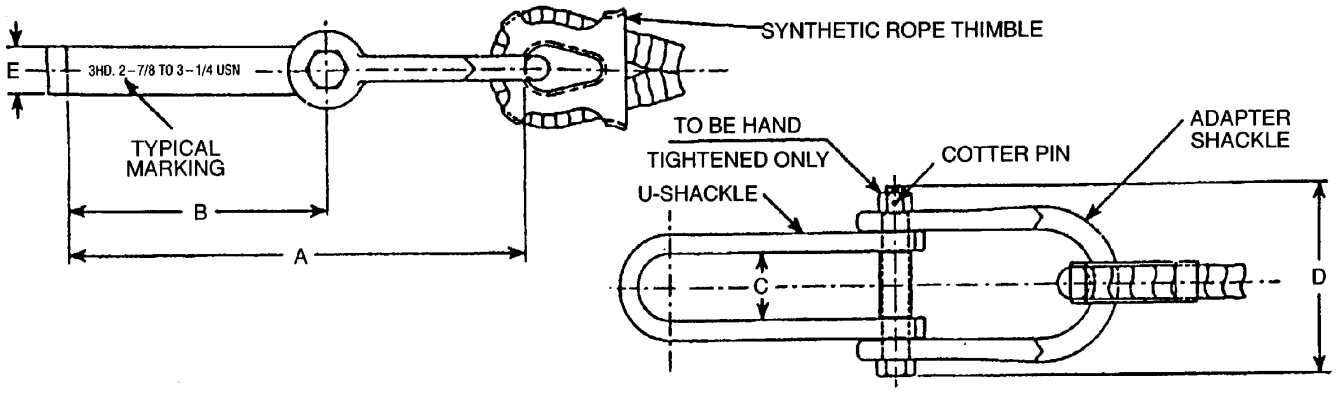


Figure 581-6-14 Clear Hawse Pendant

581-6.2.11 DIP ROPES. Dip ropes are used in buoy mooring, clearing a hawse pipe or dipping the anchor. A dip rope can also be used to clear an anchor buoy line if it is fouled with the chain or anchor. The dip rope is a nylon rope pendant fitted at one end with an adapter shackle, synthetic rope and thimble, and on the opposite end with a U-shackle assembly that is large enough to engage a link of anchor chain. Dip ropes are shown and dimensioned in Figure 581-6-15 and on NAVSEA dwg 803-6397319.



Chain size[1]									Nylon rope size[2]		
Heavy duty (HD)	High–strength (HS)	Standard	A	B	C	D	E	Thimble size	CRCMF (inch)	Length (fms)	Dip rope assy proof load (lbs)
	3/4 – 7/8	3/4 – 1–1/8	8–7/8	4–3/4	1–1/4	4–3/4	1–9/16	2 – 2–1/4	2–1/4	14	15,800
	1 1–/8	1–1/4 – 1–1/2	11–7/8	6–3/8	1–5/8	5–7/8	1–7/8	2 – 1/2 – 2–3/4	2–1/2	14	18,400
	1–1/4 – 1–1/2	1–5/8 – 1–7/8	14–3/4	7–7/8	2	7–1/16	2–1/8	3	3	24	27,800
	1–5/8 – 1–3/4	2 – 2–1/4	17–5/8	9–3/8	2–7/16	8–1/4	2–3/8	3–1/2 – 3 3/4	3–1/2	30	38,400
2–3/4		2–3/8 – 2–3/4	21–5/8	11–1/2	3	9–1/8	2–5/8	4	4	36	49,500
3		2–7/8 – 3–1/4	25–1/2	13–1/2	3–1/2	10–3/8	2–7/8	4–1/2	4–1/2	36	60,000
3–1/2		3–3/8 – 3–3/4	29–3/8	15–1/2	4–1/16	12–3/8	3–3/8	5	5	36	72,000
		3–7/8 – 4	31	16–1/2	4–5/6	12–5/8	3–3/8	5	5	36	72,000
		4–3/4	36–5/8	21	5–1/8	14	3–5/8	5–1/2	5–1/2	36	86,500

[1] HS referes to high–strength, die–lock chain and HD referes to heavy–duty, die–lock chain. Standard chain refers to flash–butt–welded type.
[2] Double–braided

Figure 581-6-15 Dimensions for Dip Ropes

581-6.2.12 CABLE JACKS. Cable jacks are normally used for handling anchor chain of 2-3/4 inch and larger sizes. Smaller size anchor chain may be handled with a pinch-point crowbar, NSN G5120-00-224-1 390. The cable jack is a lever, mounted on an axle and two wheels. The lever has a steel tip on the short end for engaging the chain. Cable jacks are manufactured per the requirements and dimensions shown on NAVSHIPS dwg 804-860302. A cable jack is illustrated in Figure 581-6-16.

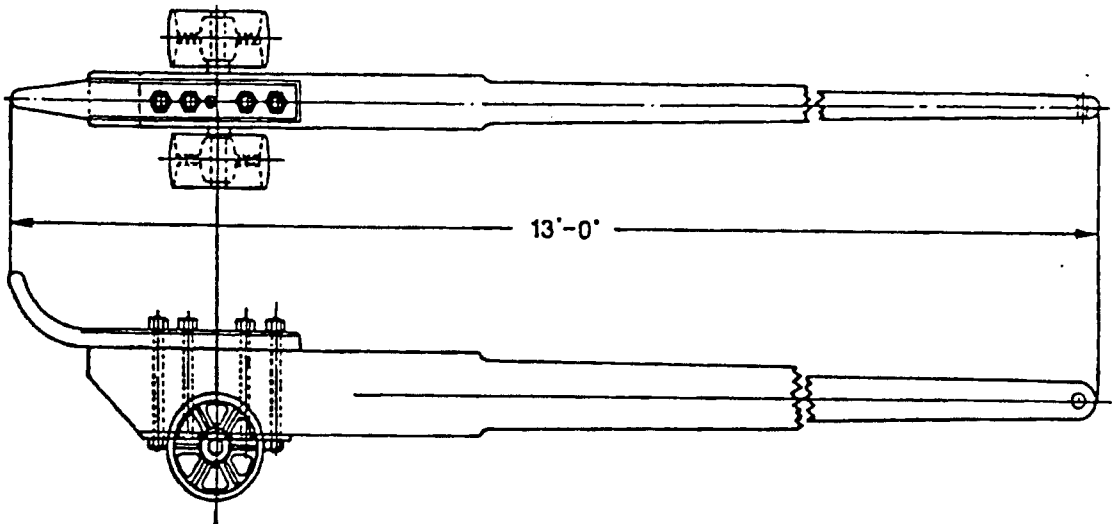


Figure 581-6-16 Cable Jack

581-6.2.13 CHAIN STOPPER WRENCH. A chain stopper wrench is used to turn the turnbuckle to shorten or extend the chain stopper. The wrench fits the hexagon shape in the middle of the turnbuckle housing. The material requirements and dimensions are on NAVSHIPS dwg 804-860000.

581-6.2.14 DETACHABLE LINK TOOL BOX SETS. Detachable Link Tool Box sets, NAVSHIPS dwg 804-840327, are provided for use in assembling and disassembling detachable links. The tools, with replacement taper pins and lead plugs, are enclosed in a metal box and include a hammer and two punches. The larger punch is used to drive out the tapered pin and the smaller punch is used to remove the hairpin.

581-6.2.15 CHAIN COMPRESSORS. The Navy has no standard for chain compressors. Chain compressors are used on a few ships with one windlass and two anchors to prevent the chain from sliding into the chain locker when it is disengaged from the wildcat. Chain compressors are also used on surface ships with keel-mounted anchors to restrict anchor chain movement in the longer hawse pipe. The movement will cause considerable noise at higher sea states or noise that interferes with some of the listening operations on the ship. The chain compressor is designed to stop a free-running anchor chain, with the anchor on the bottom, at depths up to 25 fathoms (150 ft). Release the chain compressor before hoisting or lowering the anchor.

581-6.2.16 MOORING SWIVELS. Mooring swivels, with two detachable links attached at each end, are used when anchoring with two anchors by the ordinary or flying moor method. This allows the ship to swing without twisting the two anchor chains around each other. Mooring swivels are manufactured per the requirements and dimensions shown on NAVSHIPS dwg 803-5959226. A mooring swivel, deleted from carriers only, is illustrated in Figure 581-6-17.

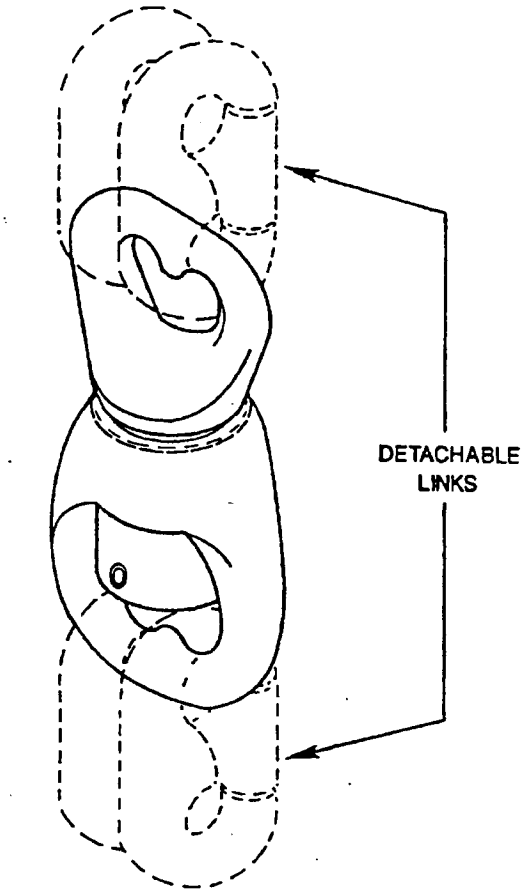


Figure 581-6-17 Mooring Swivel

581-6.3 MAINTENANCE, INSPECTION AND STORAGE

581-6.3.1 GENERAL. The ship's force is responsible for keeping the chain appendages in good condition. Inspect chain appendages once each quarter for cracks, damage, defects, deformation, wear and missing parts. This inspection shall include the padeyes for the chain stoppers. Increase the inspection frequency if the ground tackle is subjected to abnormal use.

581-6.3.1.1 Painting. Appendages that require painting shall be cleaned of all foreign matter or sandblasted, if required, and painted with two coats Epoxy Polyamide, green primer, Formula 150 per MIL-P-24441, three mils thick each coat and two coats, Silicone Alkyd enamel, black, 3-mil dry film thickness each coat in accordance with DOD-E-24635, color 27038 for overhaul, maintenance or touch-up. As an alternative, FED Spec TT-V-51, black asphalt varnish, two coats, 3-mils dry film thickness each coat may be used in lieu of DOD-E-24635.

581-6.3.2 STORAGE. Store chain appendages on raised platforms according to size. Shackles should be stored in pairs according to size. Small parts, such as tapered-pins, locking plugs and hairpins, should be segregated according to the chain size with which they are used. It is preferable to store the small parts in compartments constructed for this purpose. Take precautions to prevent machined surfaces from corroding in extended storage by using a suitable rust-preventive coating.

581-6.3.3 END LINKS. The stud in a forged end link is permitted to have a separation that is parallel to the length of the link. The separation exists in all end links made by the die-lock forging method. Most of the die-lock-forged end links were made by the Boston Naval Shipyard and there are no manufacturer trademarks on the forgings. The separation is not injurious to the end link strength or performance because the stud is forged integral with the link. However, if the stud is welded in place, then no crack is permissible.

581-6.3.4 DETACHABLE LINKS STANDARD AND PEAR-SHAPED. Coupling plates on new standard detachable and pear-shaped detachable links shall have no movement along the axis or at 90 degrees to the axis when assembled. Either coupling plate movement on used standard detachable or pear-shaped detachable links, examined between an 18 to 36 month period, shall not exceed 1/32-inch for sizes 3/4 through 1-7/8 inches, 1/16-inch for sizes two through 3-1/4 inches, and 3/32-inch for sizes 3-3/8 through 4-3/4 inches. The detachable links (standard and pear-shaped) are to be replaced if these allowances are exceeded. Vernier calipers, a micrometer or a 6-inch machinist rule shall be used for measurement. This criteria applies whether the links have match marks or not.

581-6.3.4.1 The coupling plates and C-link forged part of standard and pear-shaped detachable links are not inter-changeable. The coupling plates and C-link are pressed together by the manufacturer during assembly. The tight fit of the coupling plates on the C-link is essential to the detachable link strength. Thus, mixing the pieces when reassembling will destroy the original fit. The pieces are match-marked (see Figure 581-6-5) to aid detachable link reassembly. Also, tapered pins should not be interchanged. Inspect tapered pins for straightness, peening and cracks.

581-6.3.4.2 Prior to assembly or reassembly, the internal matching surfaces of detachable links should be liberally greased with sea water wash resistant grease (CID A-A-50433, NSN 9G-9150-01-306-9167). Detachable link maintenance, which includes cleaning, inspecting, painting and lubricating, is determined by the ship's Planned Maintenance System (PMS).

581-6.3.5 CHAIN STOPPER TURNBUCKLE. Inspect the condition of the lubricant on the chain stopper turnbuckle and rod eye's thread before starting an anchoring or towing evolution. If the lubricant is dry or contaminated with dirt, grit, or foreign material, remove the lubricant, clean the surfaces and add new lubricant. It is essential that the turnbuckle assembly turn easily during the chain stopper adjustment. When adjusting the chain stoppers, personnel can estimate that they have distributed the load equally between the chain stoppers by applying approximately the same force on the chain stopper wrench at each chain stopper.

581-6.3.6 CHAIN SWIVELS. Chain swivels should rotate as freely as possible. Clean the chain swivel to remove dirt, grit, sand and foreign materials from the clearance between the swivel basket and the swivel eye. Do not lubricate the phosphorous bronze washer with a heavy grease. Do not heat with a torch as the strength will be reduced. Soaking in cleaning solvent or heated oil is permissible.

581-6.3.7 PROOF LOAD TEST. The chain appendages are proof load tested by the manufacturer. The ship's force or repair activities shall not proof load test them again. Do not ship chain appendages to another facility for additional proof load testing.

REAR SECTION

NOTE

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